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ENGINEERING EDITION.

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New Series, Vol. I.

September, 1902, to August, 1903.

1903.

THE INDUSTRIAL PRESS,
66 WEST BROADWAY,
NEW YORK.

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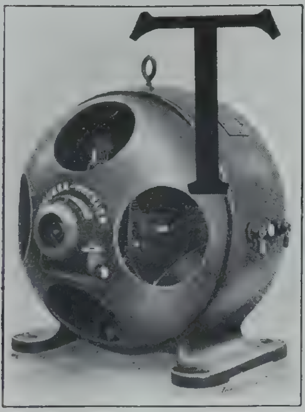
MACHINERY.

September, 1902.

ELECTRICITY AS A MOTIVE POWER FOR MACHINE SHOPS.

WITH SPECIAL REFERENCE TO THE ELECTRICAL EQUIPMENT OF THE WILLIAM R. TRIGG CO., RICHMOND, VA.

WILLIAM BURLINGHAM.



THE arguments against the installation of electric motors for machine shops are constantly decreasing with the increase of the motor systems. For new shops the argument against the use of electricity is nil. For rehabilitating old shops, there are naturally many points to be considered, the principal of which are: Dismantling the driving mechanism of old machines and installing new motors; loss of shafting and appurtenances, boilers, engines, etc. The boiler power necessary would then be, only that used for heating the plant. To reimburse a firm for so doing, necessitates that the economy and improved feed adjustment due to the electric motor driven machines must earn a good interest on money lost on old installation plus that invested in the new driving machinery. The convenience of being able to work one tool only, on a hurry job, without being compelled to run the entire line of shafting, is one factor of economy. The mobility of the tools is another especially on light machinery.

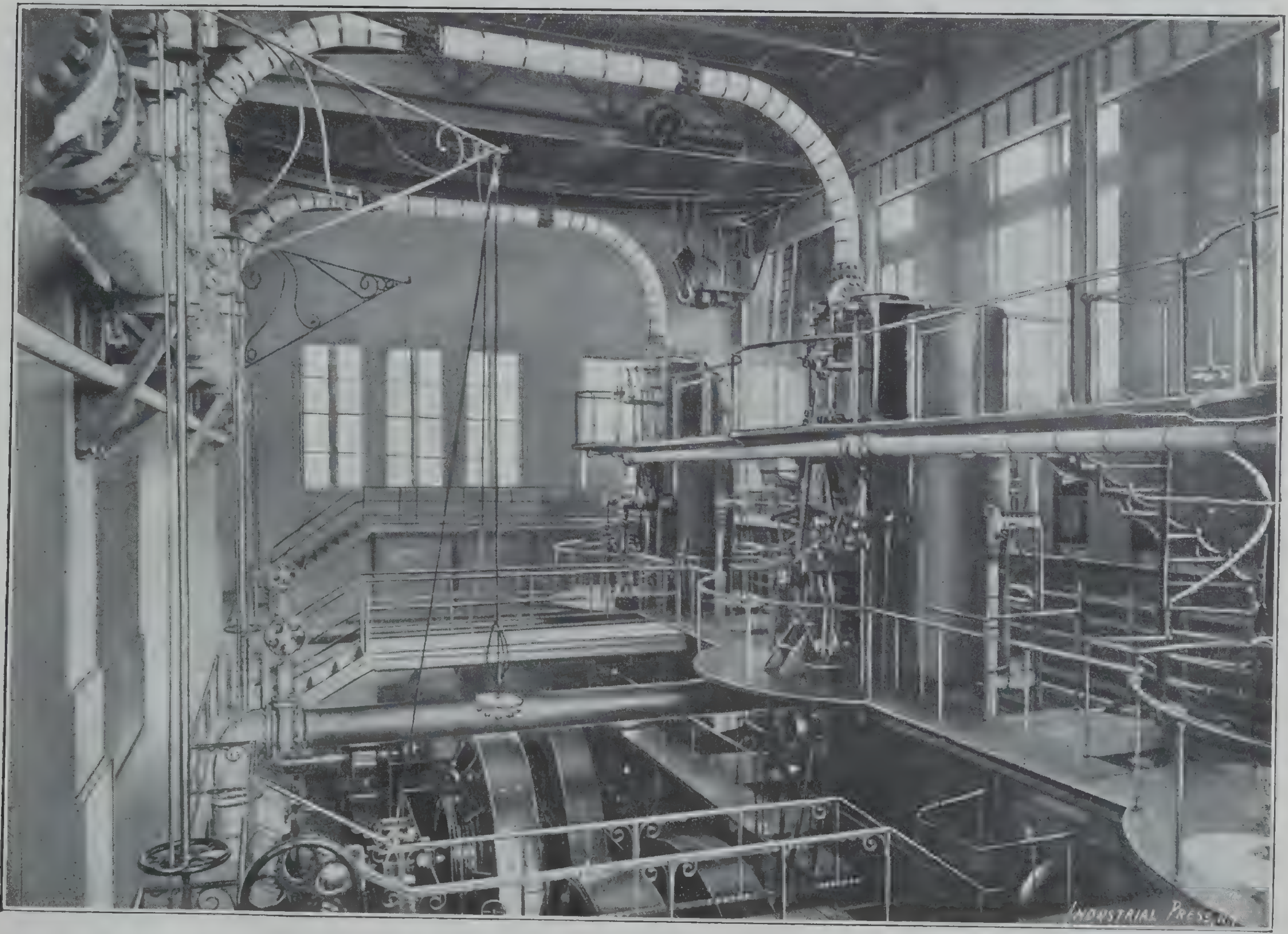


Fig. 1. Interior of Engine Room of the Virginia Electrical Railway & Development Co., which supplies the Current for the Shops of the Wm. R. Trigg Co.

The general impression is that in an electrical installation, the only saving factor is that due to the economy caused by lack of countershaft and main line shaft friction; by the smaller number of men necessary to manage the power plant; by getting rid of the condensation of steam in the pipes of a large plant supplied from a central boiler installation, and by the smaller amount of money invested in power conductors. The fact is that *the greatest* economy is often lost sight of, and that is the power of an electrically-driven machine of the modern type, if really driven, to save time and therefore money by its power of varying the cut to suit the work. The latest installations have twelve speeds under control of the operator and so it is comparatively easy for him to run his cut to the full capacity of the cutting tool. With the ordinary cone pulley and countershaft drive the best cutting speed is as liable to come between the cone speeds as it is to come exactly on the cone speed. This is the item in which experience in the use of motor-driven tools, has shown in a high degree the economical range of the electric motor. Another great advantage of the system is its adaptability to overtime work.

How many of us have seen an entire plant of 200 horse power in operation, merely to face off a flange or to turn a pulley. It can be easily seen that a few such jobs would pay for placing motors on all the shop machinery that is liable to be used for such purposes.

The improvement in the daylight illumination of such shops must be seen to be appreciated to its full value, and the extra space secured for the use of the cranes in the rapid handling of material is another argument in favor of its adoption.

This is also one of the factors by which the output is increased unconsciously.

For the old shops with low ceilings, of which there are many in this country, the low countershaft and short belts do not allow the machines to be used to their full capacity, because of the belt slipping. This may be a small item, it is true, but at the present time when competition is so keen, all these items count in the cost of the product. It has been found from experience that the personnel of the men is improved and that they are more apt to drive the machines to their full capacity.

The shop is neater and cleaner, there are fewer corners for the reception of dirty waste, and tools are not so easily mislaid. Another point seldom brought up is the increased floor capacity of a shop, due to the use of these tools. No room need be allowed for belt drives, and tools as a result can be brought closer together; and because there is no line shafting running in a fixed direction, the tools need not be located for favoring belt drives, but can be placed fore and aft the shops, or crossways, in fact in the direction best suited for their intended work, or in the space most convenient.

In a machine shop or manufacturing establishment of ordinary size the power is usually transmitted from one or more engines by means of belting, long lengths of line shafting and countershafts. The amount of power necessary to keep this mass of shafting and belting in motion is a very large percentage of the maximum output of the engine, as high as 70 per cent at times and an average of 40 per cent at least of this total power developed. It is evident that this same loss will take place whether the shop is running at its maximum or at one-quarter of its rated capacity.

The electric drive has, of necessity, a loss between the engine and the point of application of the power; but as electric systems are designed to-day this loss is comparatively small with everything under way—much less than with the belt system. It has the added advantage of being lessened proportionally as the various machines are cut off, and they do not remain a drag upon the generating plant. Such a system, therefore, permits of the use of one or more machines independently of the others, with a percentage loss referred to the machine in use, and not to the maximum output of the plant. It is also evident that with this great frictional loss in the belt drive, the power plant must be, on an average, twice as large as its more economical competitor, the motor drive. Now considering the comparative cost of all the elements of each system, we find that the first cost of the electric system is not at all expensive compared with its opponent, for the following reasons: First, the size of the power plant is cut down; secondly, the belts, line and countershafts are taken out, and thirdly, the steam pipe system is greatly decreased. Against this we have the addition of the generators, motors and wiring. It has been demonstrated in several factories that this favorable cost of installation of electricity as compared with steam is a fact. When we consider this cost, the economy of operation and increase in efficiency of cutting tools, the advantages of this system become self-evident.

It is not necessary that there be a large central station in the neighborhood as a source for the power, because one can generate one's own electricity cheaper than one can buy it in the majority of cases. We are not all located near Niagara Falls or the James River. I give a few figures from the plant of the Curtis Publishing Company, Philadelphia, Pa., from the "Electrical Review."

"This plant consists of three Babcock & Wilcox, 250 horse power, boilers at 160 pounds steam pressure, with a Green economizer of 600 horse power and induced draft. For regular work there are three large units of 200 kilowatts, 250 volts continuous current Westinghouse generators, each driven by engines 14½ and 28 inches by 18 inches stroke, tandem compound, at a speed of 200 revolutions equal 325 indicated horse power.

"For night and Sunday work, watchman's lights, etc., there is one small unit 50 kilowatts 250 volts driven by an engine 11 by 12 inches, 275 revolutions per minute, developing 80 horse power. The exhaust steam is used for heating purposes, and to keep the back pressure down in the low-pressure cylinder, the Webster system is used. The exhaust steam passes through a Cropson heater 600 horse power, returning to the feed water heater at a temperature of about 170 degrees F. The cost of running this plant for a month was $1,455.53, 41.3 per cent of this being for fixed charges (taxes, insurance, interest, depreciation, repairs, etc.). The heating cost averaged throughout the year, per month $211.83, leaving net cost of $1,244.50. During the month there was delivered to the switchboard 83,400 kilowatt hours or 111,510 horse power hours. The net cost therefore per kilowatt hour was 1.49 cent and per horse power hour 1.11 cent.

"The average price from a central station would be from 2 to 3 cents per horse power hour. The comparative economy of the isolated and central station plant can be easily seen."

The Power Plant of the Virginia Electrical Railway and Development Co.

The reasons for the higher prices of the central station are due to the fact that it costs them nearly as much to deliver the goods as it does to generate it, while the isolated plant has the added advantage of using the exhaust steam for heating the buildings. It must be understood that these figures refer to complete, up-to-date plants, and not to a motor stuck up in solitary grandeur in one corner of a machine shop. The machine, boiler, ship fitting shop, in fact the entire plant of the shipbuilding firm of the William R. Trigg Company, Richmond, Va., is fitted with the latest modern types of electric motors. This company do not generate their own electricity as they are exceptionally fortunate in their situation, their current being supplied to them by the Virginia Electrical Railway & Development Company. The power house of the Virginia Development Company is 250 feet long by 112 feet wide. The total available fall of water at the power house is 25 feet. The turbines are situated in submerged chambers beneath the boiler rooms.

There is also a complete steam auxiliary for use during one month in the year when the river is in flood from the spring freshets. The plans provide for 11,000 horse power in 11 units. The turbines were made by the Stillwell-Bierce & Smith-Vaile Co. They are the regular type of submerged horizontal turbines 2-51-inch working together making one unit. A Lombard water wheel governor is used for controlling them. The generators are from the General Electric Co., of the heavy railway type, rated at 750 kilowatts each; direct current 500 volts multipolars at 110 revolutions per minute. The armature shaft carries an 87,000-pound flywheel, which runs with the turbine as well as with the engine. When the engines are used, the coupling bolts are withdrawn between the turbines and generator and the engine coupled, the operation requiring about fifteen minutes. The engines are vertical steeple compound, made by Allis-Chalmers, and are 20 and 40 inches by 42 inches stroke, fitted with Reynolds-Corliss valve gear, operated by two eccentrics, the steam and exhaust valve being operated by different eccentrics. Their best economy is obtained when working at 800 horse power, with a maximum capacity of 1,500.

The main steam line is 14 inches diameter and the exhaust line or header is 36 inches, exhausting into a Worthington siphon condenser. There are six batteries of Babcock & Wilcox boilers of two boilers each, a total of 12 boilers; steam pressure 150 pounds, 500 horse power each, with a guarantee for 50 per cent. overloading. The Holly system of draining is used for the steam pipes, the water being returned to the boilers. The switchboard is built on a gallery about 26 feet above the engine room floor. An underground conduit system of Edison tubes is used. Those at present laid down in the city have a length of about 70,000 feet.

The capacity of the plant has been extended by the addition of a storage battery for use in the lighting system. During the morning hours when the demand for current is comparatively light, these batteries are charged and drawn on later for the evening supply. It was furnished by the

Electric Storage Battery Company of Philadelphia. There are 280 elements of their latest improved type, installed with 140 cells in series on each side of the three-wire system. The capacity of the battery at about 70 degrees F., is 180 amperes for 8 hours, on each side of the system, with a maximum pressure at end of discharge of 238 volts. This company are also part owners in the Richmond Industrial & Development Company, who have constructed a modern factory building of brick, in which tenants may rent any space they desire, with any amount of power, very suitable for small industries or experimental work. This venture is succeeding and is very well worth the consideration of other cities that are similarly situated.

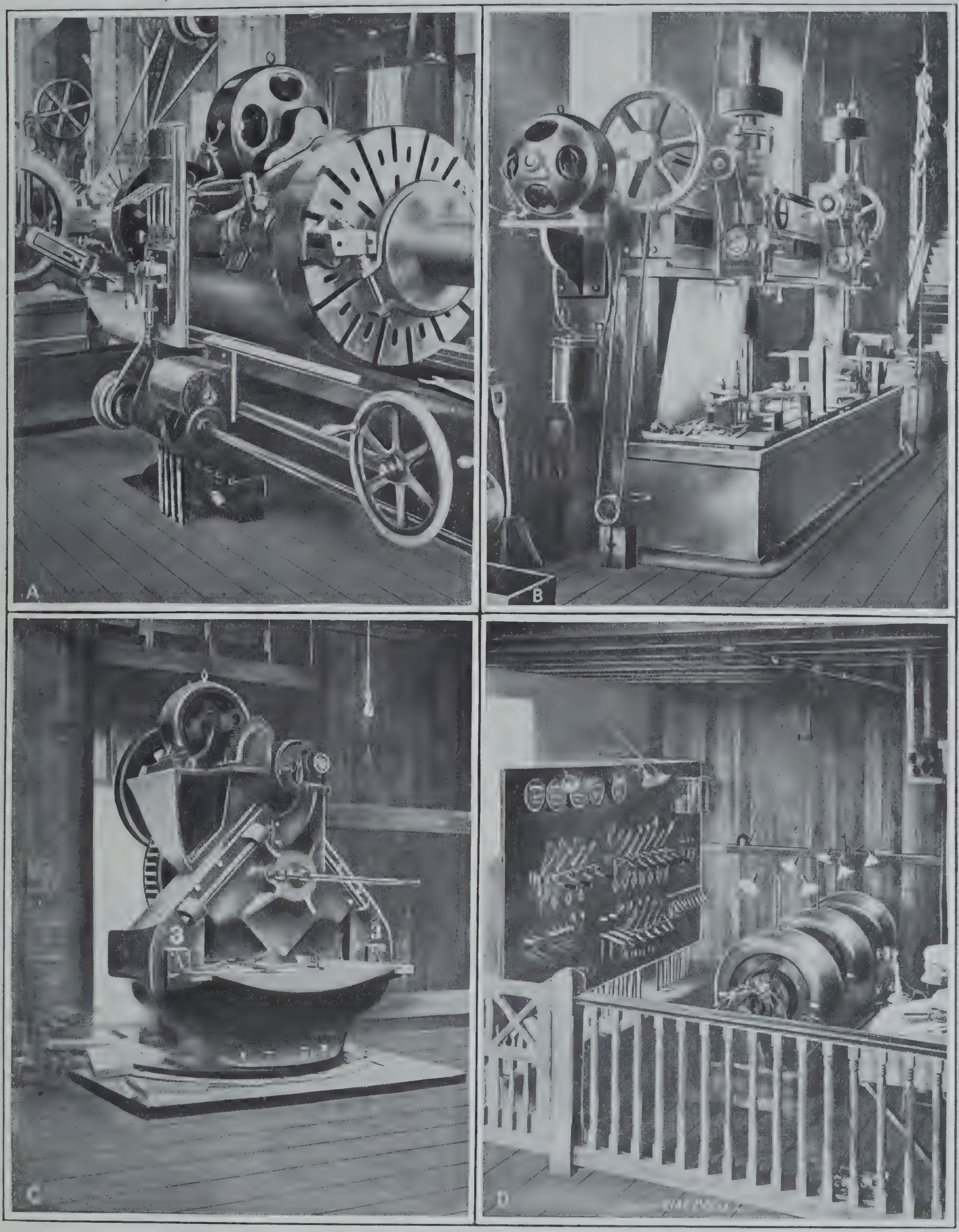
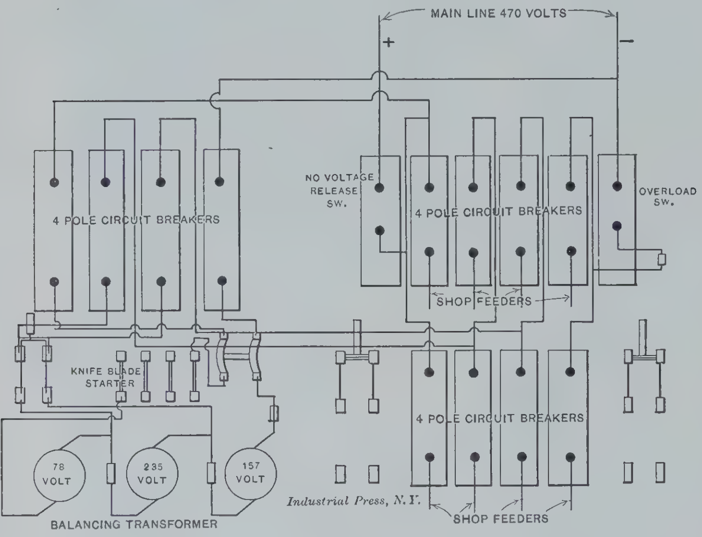


Fig. 2. A.—36 inch x 25 foot Putnam Lathe, 7.5 H.P. Motor. B.—Newton Duplex Rod Boring Mill, 7.5 H. P. motor. C.—Double Angle Shear, 10 H. P. motor. D.—Rotary Transformers and Switchboard.

The Equipment at the William R. Trigg Co.'s Works.

The plant installed in the machine shop at the works of the William R. Trigg Company is the "four-wire multiple voltage system," as developed by the Crocker-Wheeler Company, Ampere, N. J. The ship fitters' tools, etc., are run by constant speed motors, all, with one or two exceptions, of the Crocker-Wheeler manufacture. The multiple voltage system works excellently in practice. One man looks after 96 motors in addition to his other work. The men easily become accustomed to the methods of operating the machines and express themselves as well pleased with the system, claiming that they would never go back to the old belt system if they could help it. Their work is under perfect control, as they are able to instantly stop the tool at any part of the work. The work is turned out quicker, it may be unconsciously, but the fact remains that less time is taken to do a certain job than with the old methods, even with the few months' practice they have had. The method of the electrical operation is shown in Fig. 3.



Industrial Press, N.Y.

Fig. 3. Plan of Wiring of Four-wire System used at the Wm. R. Trigg Works.

In one corner of the machine shop is the electrical department, which contains the balancing transformer, with polished slate switchboards, shown in Fig. 2, D. To this switchboard the current is delivered at a difference of potential of 470 volts. The positive wire leads to an I. T. E. 500 ampere, no voltage release breaker, or in other words, a breaker that automatically cuts or breaks the circuit whenever the voltage of the main supply ceases. There is also an ordinary breaker of the same capacity for the negative wire. The current is then conducted to 200-ampere breakers and from them to a Crocker-Wheeler cut-off blade starter, the latest type of which is shown in Fig. 4. A closing cut-off switch of iron and mica sections completes the circuit through the motor and starting resistance. The resistance is then cut out step by step by closing the knife blade resistance switches. An interlocking device prevents the switches from being closed in any but the proper order. If the line voltage fails, the cut-off switch opens, thus disconnecting the motor from the line, which cannot be replaced without opening all the resistance switches. From this the current is conducted to each end of the set of balancing transformers, one to the 78-volt and the other to the 157-volt machine. There are three rotary transformers on a common shaft, and they transform to a voltage of 78, 235 and 157 respectively. They run at a common speed of 1,100 revolutions per minute.

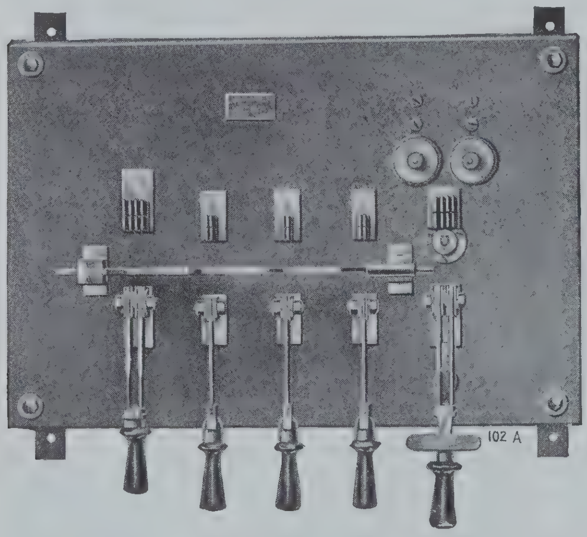


Fig. 4. Crocker-Wheeler Cut-off Blade Starter.

From a conductor connecting the 157 and 235-volt and the 78 and 235-volt transformers, wires are led to a double-pole switch. From this switch they are connected to two 150-ampere I. T. E. breakers; and from thence each line leads to a pair of 150-ampere breakers. It will be seen from the accompanying plan of wiring, Fig. 3, that there are two sets of four breakers on the panel board, one above the other, one for each side of the machine shop. The combination of voltage possible is as follows:

$$78 = 78$$
$$157 = 157$$
$$235 = 235$$
$$78 + 235 = 313$$
$$157 + 235 = 392$$
$$78 + 157 + 235 = 470$$

This four-wire system extends to each motor in the shop through a switch and circuit breaker, the object of the breaker being that if the tool should bite or gouge into the work and throw a heavy load on the motor, it will immediately break connections, saving burning out the armature, etc. From this controller, of which Fig. 5 shows a method of connections, the current enters the motor on the machine. The principle of operation is as follows: On the first notch of the controller the motor is thrown into circuit with the 78-volt current, and certain constant resistance in the armature circuit. The second notch throws out this extra armature resistance; the third notch, the 157-volt current with the same resistance as at first; at the fourth notch this resistance is thrown out and so on for twelve notches, giving the machinist twelve motor speeds, and on a lathe that is back-geared, this may give him forty or fifty speeds to work with, enabling him to find that requisite for any class of work. It is not until one has had this variation of speed at his command that the economy of it can be appreciated. Suitable fuses are, of course, distributed throughout the line, but the location of these is more for the electrical than for the mechanical end, as our province is to understand the general working of the system only.

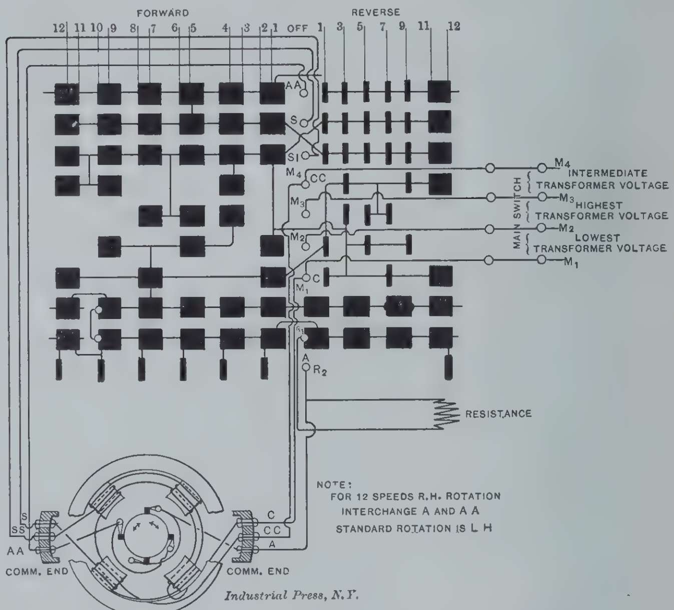

FORWARD
REVERSE
12 11 10 9 8 7 6 5 4 3 2 1 OFF 1 3 5 7 9 11 12
AA
S
S1
M4
CC
M3
M2
C
M1
A
R2
MAIN SWITCH
M4 INTERMEDIATE TRANSFORMER VOLTAGE
M3 HIGHEST TRANSFORMER VOLTAGE
M2 LOWEST TRANSFORMER VOLTAGE
M1
RESISTANCE
NOTE: FOR 12 SPEEDS R.H. ROTATION INTERCHANGE A AND A A STANDARD ROTATION IS L H
SS
AA
COMM. END
C
CC
A
COMM. END
Industrial Press, N.Y.

Fig. 5. Connection Diagram of Controller for Reversing Compound Motor.

The circuit breakers used, I T E, have an adjustment from 25 per cent. below to 50 per cent above the actual rating, and at this actual rating they do not exceed 20 degrees above the temperature of the surrounding atmosphere.

The type of motor used by the William R. Trigg Company is that manufactured by the Crocker-Wheeler Co. With these machines the full load may be thrown on or off instantly without causing any sparking or necessitating any readjustment of the brushes. They behave similarly when the load is raised from one-fourth normal load to 25 per cent overload and they withstand loads 50 per cent greater than rated capacity without appreciable sparking. The rise in temperature is not greater than 40 degrees above surrounding air after a five-hour full load run. An overload of 25 per cent can be carried for an hour without increasing this rise over 5 degrees and a 50 per cent. overload can be carried momentarily. The armature is well ventilated, the commutator surface large, the field coils well protected and mechanical parts are amply strong. The field coils are wound upon cylindrical heavy insulated bobbins, which are removable from the poles by taking off the pole shoes. The armatures are wound with round wire triple cotton covered and the coils are continuous from commutation bar to commutation bar. Provision is made for circulation of air in the interior of the armature and out through the commutation connections. The current density of the brushes range from 20 to 40 amperes per square inch for ordinary carbon and for carbon interleaved with gauze as high as 70 or 80 amperes per inch.

The standard belt speed ranges from 2,000 to 4,500 feet per minute, depending upon the size of the machine. The number of square feet of belt surface per horse power averages from 70 to 90 per minute for single belts and 45 to 55 per minute for double belts.

The speeds of the standard load do not vary more than 5 per cent. when the load raises from 0 to full load. The moderate speed machines give increased output over the same size low speed and run nearer the sparking and heating limits, but are claimed to run in every way satisfactorily.

STANDARD SPEEDS FOR MOTORS.

Standard Low.		Weights.	Standard Moderate.	
Horse Power.	Revs. per min. at 500 Volts.		Horse Power.	Revs. per min. at 500 Volts
225	425	23210	170	530
150	480	12800	125	675
100	530	6825	90	690
75	570	6850	60	870
50	660	4315	45	1000
35	730	3215	32	1050
25	780	2325	26	1100
20	820	1790	20	1250
15	840	1465	13	1175
10	880	965		

Weight does not include pulley, base, frame or rails, or blade starter.

The present installation of motors at the Trigg Company's works is equivalent to 1,152.75 horse power and the present mean load with all air compressors running is 331 horse power, or 28.8 per cent of the sum total of motor horse power.

It is proposed to install a new air compressor, 200 horse power; 3 Gantry cranes, 75 horse power; a shaving exhaust system, 32 horse power, and 2 caisson pumps (25 horse power each), 50 horse power.

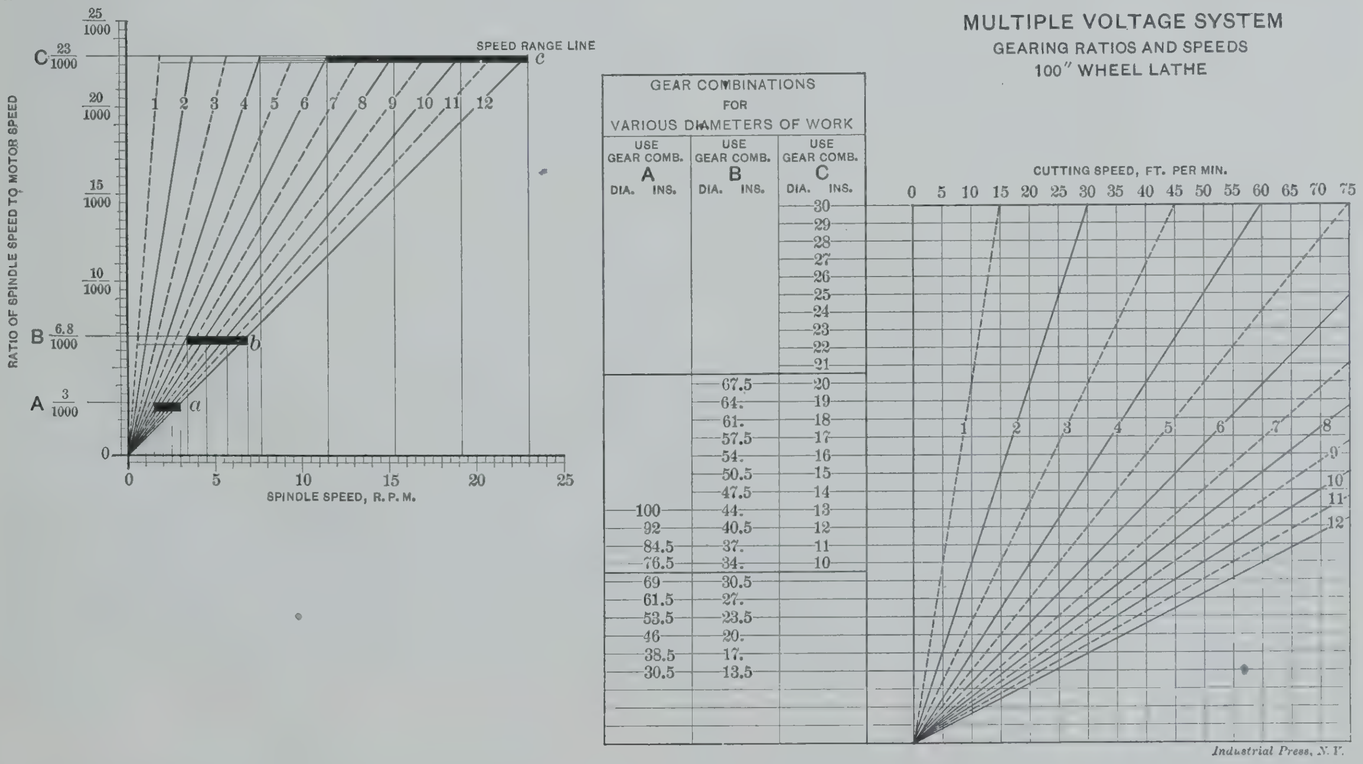
From the present figures we can see that only about 30 per cent. of the available horse power is in average use. With the engine and belt system we could easily use up this amount in friction on a 1,500 horse power plant and we would have this same amount of friction if we were running a 5 horse power machine or the entire system, whereas with the motor system the friction is practically proportional to the power used. With an isolated plant under ordinary conditions, we can probably figure about 1½ cent per kilowatt hour, or 1.11 cent per horse power hour.

The efficiencies of these motors are as follows:

H. P.	Full Load.	¾ Load.	½ Load.	¼ Load
225	93.5	92.5	80.4	84.7
150	92.1	89.8	86.3	76.5
100	93.0	92.0	89.6	83.1
75	90.7	89.5	86.5	77.2
50	90.1	88.5	84.8	74.4
35	89.5	87.5	83.5	73.3
25	89.4	87.0	82.5	70.5
20	88.5	86.7	82.7	71.5
15	86.5	85.3	80.3	68.3
10	85.5	85.4	83.0	74.5

This shows the high efficiency of these machines and the small loss due to their employment as an intermediary, compared with the usual belt pulley and shafting.

The motors in this shop are either compound series or shunt-wound. The diagrams of the windings are given in Fig. 8.



GEAR COMBINATIONS FOR VARIOUS DIAMETERS OF WORK

USE GEAR COMB. A DIA. INS.	USE GEAR COMB. B DIA. INS.	USE GEAR COMB. C DIA. INS.
		30
		29
		28
		27
		26
		25
		24
		23
		22
		21
	67.5	20
	64.	19
	61.	18
	57.5	17
	54.	16
	50.5	15
	47.5	14
100	44.	13
92	40.5	12
84.5	37.	11
76.5	34.	10
69	30.5	
61.5	27.	
53.5	23.5	
46	20.	
38.5	17.	
30.5	13.5	

Chart I. shows the determination of the gearing ratios of a 100-inch wheel lathe operated by an electric motor on a multiple voltage system; also the spindle speed of the lathe for each gearing ratio and voltage.

Chart II. shows the proper gearing ratio and voltage to obtain a given cutting speed with work of a given diameter. Plotted for a range of diameters of from 10 inches to 100 inches on diameters over 30 inches, maximum depth of cut and feed. On diameters under 30 inches, two-thirds maximum depth of cut or feed.

Cutting speeds from 15 to 60 feet per minute.

A system of six voltages of relative values, 2, 4, 6, 8, 10, 12.

Controller positions 2, 4, 6, 8, 10, 12, corresponding to these voltages and controller positions 1, 3, 5, 7, 9, 11, intermediate between them.

A motor, of which the normal speed is 1,000 R. P. M., capable of supplying at half this normal speed the maximum horse power demanded, which is 20 horse power; and capable of supplying at one-third this normal speed the lesser horse power demanded by lighter cuts on diameters under 30 inches, which is 13.3 horse power.

Three combinations of gearing.

Fig. 6. Gearing Ratios and Speeds, 100-inch Wheel Lathe.

The charts, Fig. 6, page 5, of the gearing ratios and cutting speeds of a 100-inch wheel lathe show the method that is used for determining the correct speed ratios and the combinations of gears necessary for a certain cutting speed. This principle is applicable to all classes of machine tools and explains itself.

Electrical Equipment in Ship Fitters' Shed.

The ship fitters' shed of the Trigg Company is fitted up entirely with constant speed motors, equipped with double pole switch and Cutler-Hammer starters. The operation of the tools is very satisfactory. There is a line of shafting at each side of the shed; the west side driven by a Crocker-Wheeler, type D, 15 horse power motor, shunt-wound, 800 revolutions per minute, 470 volts and 27.5 amperes. This motor, as well as that in the east side, is attached to the lower chords of the roof trusses, which also hold the hangers.

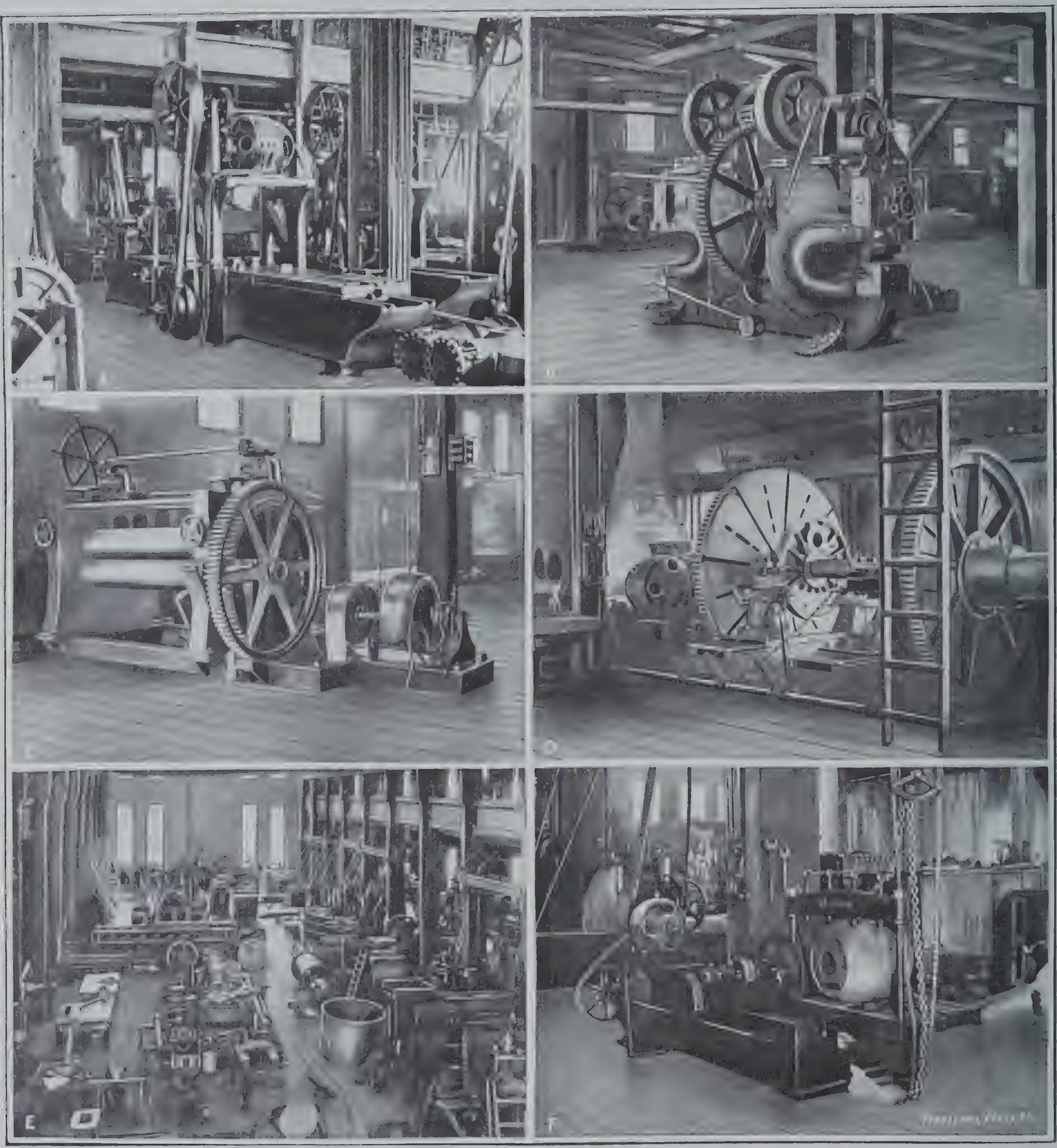


Fig. 7.

A.—36-inch Planer, 15 H. P. Motor.
B.—No. 3 Double Punch, 10 H. P. Motor.
C.—12-foot Straightening Rolls, 15 H. P. Motor.
D.—100-inch Wheel Lathe.
E.—View of the Machine Shop.
F.—Newton Cold Saw, 5 H. P. Motor.

This 15 horse power motor drives a grindstone and seven tools, viz.: One Bethlehem rotary shear, No. 4; two Hilles & Jones punches, No. 1; one Hilles & Jones punch, No. 0; one Hilles & Jones shear, No. 1; one set of straightening rolls, 8 rolls 6½ inches diameter 4 feet long, and one Hilles & Jones angle shear, No. 3.

On the east side there is a Milwaukee motor, shunt-wound, type 30 B, 30 horse power, 625 revolutions per minute, 500 volts (run at 470), 50 amperes. This motor drives a grindstone and six tools, as follows: One 5-foot radial drill; one small vertical drill; one rivet making machine, Acme; one counterboring machine, Fitchburg Machine Works; one plate planer, side, Hilles & Jones, No. 0, and one set of light bending rolls, 18 feet long, Hilles & Jones.

The other tools are separately driven, each by its own motor, viz.: Large bending rolls, Hilles & Jones, 22 feet 2 inches between heads, diameter of top roll 27 inches and diameter of bottom rolls 23 inches; three-roll machine. The roll-driving motor is of the C. & W. type, 35 D, compound-wound, 35 horse power at 470 volts, 58.5 amperes and 700 revolutions. The top roll is lifted by a C. & W. 10 D compound-wound motor, 10 horse power, 470 volts, 17 amperes and 800 revolutions. These motors start very gradually, as the resistance of the controller is thrown out and are fully up to their work. It would be preferable, however, to have the lifting motor series wound.

The straightening rolls, Hilles & Jones, are 12 inches diameter, 6 rolls each, 6 feet long, with a C. & W. compound-wound motor, 15 D, and 15 horse power at 470 volts, 27 amperes, 825 revolutions. The Hilles & Jones double punch, No. 3, has a capacity of punching 1¼ holes or using 14-inch shears, C. & W. motor, compound-wound, 10 D, 10 horse power, 470 volts, 17 amperes and 875 revolutions. The Hilles & Jones duplex, or side and butt planer, is 25 feet side and 8 feet butt, 2-inch plate, two 15 horse power, C. & W. type, 15 D, compound-wound motors, one for side and one for butt planing, each 470 volts, 17 amperes and 875 revolutions. The Hilles & Jones double angle shear is 8 x 8 inches, 1 inch angle thickness, 10 D, motor 470 volts, 17 amperes, 875 revolutions. The two Hilles & Jones punches, No. 4, have a 1½-inch punch or 16-inch shears, each of the C. & W. motor type, 10-I, compound-wound, 470 volts, 18.3 amperes, 850 revolutions, 10 horse power.

MOTOR SPECIFICATIONS FOR MACHINES IN SHIP FITTER'S SHED.

Tools.	Type Motor.	Maker.	Winding.	Horse Power.	Volts.	Amperes.	Revolutions per min.
22′ Bending Rolls.							
Driving..............	35D	Crocker-Wheeler	Compound	35	470	58.5	700
Lifting	10D	"	"	10	470	17	880
12″ Straightening Rolls...	15D	"	"	15	470	27	825
No. 3 Double Punch......	10D	"	"	10	470	17	875
Duplex Planer........	(2) 15D	"	"	15	470	27	825
Double Angle Shear	10D	"	"	10	470	17	875
No. 4 Punch..........	10–I	"	"	10	470	18.3	850
No. 4 Punch...........	10–I	"	"	10	470	18.3	850
No. 2 Punch..........	5F	"	"	5	470	8.7	1000
No. 3 Hor. Punch.....	7.5F	"	"	7.5	470	13	900
N. Y. Compressor........		Gen. Electric	"	100	470	175	600 to 690
Rand Compressor........	12–0	Milwaukee	"	120	500	195	580
No. 6 Sturtevant Blower.		Sturtevant	"	12	470	14	1600
No. 6 Sturtevant Blower.		"	"	12	470	14	1600
West-side Shafting	15D	C. & W.	Shunt	15	470	27.5	800
East-side Shafting	B .30	Milwaukee	"	30	470	50	625

A total horse power, exclusive of the Sturtevant Blowers, which are in the Smith Shop, of 416½. With the compressors omitted, there is 196½ for the ship shed tools alone.

The Hilles & Jones punch, No. 2, has a ¾-inch punch, 12-inch shears, a C. & W. motor, type 5-F, compound-wound, 470 volts, 8.7 amperes, 1,000 revolutions, 5 horse power. The Hilles & Jones horizontal punch, No. 3, has 12-inch gap, 1 x 1-inch punch, a C. & W. motor, compound-wound, type 7.5-F, 470 volts, 13 amperes, 900 revolutions, 7½ horse power. The New York air compressor is a General Electric, 100 horse power, 470 volts, 175 amperes, 600 to 690 revolutions. Air is delivered at 100 pounds pressure; capacity, 500 cubic feet. The Milwaukee motor has a voltage of 470 volts, 195 amperes, 120 horse power, 580 revolutions. In the smith shop are two No. 6 Sturtevant blowers, with 12 horse power Sturtevant motors, 470 volts, 14 amperes and 1,600 revolutions. Exclusive of the Sturtevant blowers, which are in the smith shop, a total H. P. of 416½. With the compressors omitted, there is 196½ for the ship shed tools alone.

Shunt and Compound Motors.

Whereas the ship shed motors are nearly all compound-wound, the motors in the machine shop are both shunt and compound-wound. Those for the ship shed have a variable load with high starting torque and for this it is necessary to have the motor compound-wound. When the load is practically constant, the shunt-wound motor is the best. In a shunt motor system the current is divided, a small portion of the total being used only for exciting the magnets, the main current being led off direct to the external circuit. In a compound motor system, the shunt and series windings are combined. There are two sets of coils on the magnets. The series coils, consisting of comparatively few turns of wire of large section and low resistance, through which all the current of the external circuit passes; and the shunt coils, of many turns of wire of small section and high resistance, through which a small portion of the total current passes. With the shunt winding the motors are practically self-regulating, that is, they maintain a constant counter-electro motive force under varying conditions of load. I give the working principles of these two types of motors for the reason that, although familiar enough to the electrical engineer, they are not at all so to the mechanical designer or machinist, for whom this article is written.

Experiments to Determine Power Required to Drive Machine Tools.

On page 8 are data derived from experiments on three of the machine shop tools, especially prepared for this article. The machines were working under ordinary shop conditions and the data were gathered during the regular work. A 62-inch x 30-foot Putnam lathe, turning a cast-iron cylinder head 36½ inches in diameter, of hard cast iron; the tool of Sanderson self-hardening steel. A motor, Crocker-Wheeler, type 10-I, shunt-wound, 10 horse power, 850 revolutions, 470 volts, 18.5 amperes.

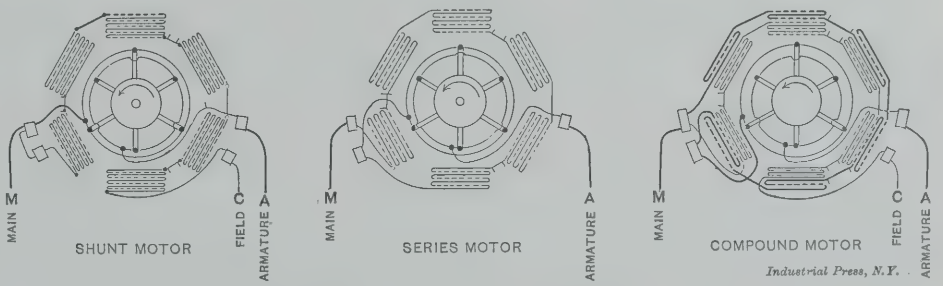


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Fig. 8. Shunt, Series and Compound Motors.

The second experiment was with a Woodward & Powell planer, 36 inches by 12 feet, of the Crocker-Wheeler motor, type 15-I, compound, 15 horse power, 840 revolutions, 470 volts, 28 amperes. The motor is located near the top of the housings, geared to a countershaft, which in turn is belted to the driving pulleys. It is instructive to learn that the reverse to cut consumed (of course for an instant only) from 2.22 to 2.29 times the power required to cut; and the reverse to return from 4.95 to 3.59 the power required to return; or from 5.11 to 3.86 the power required for cutting. There were two tools cutting on cast steel crank webs.

The third experiment was with a 36-inch x 25-foot Putnam lathe, Crocker-Wheeler motor, 7.5 I, shunt-wound, 7.5 horse power, 875 revolutions, 470 volts and 13.5 amperes; cutting shaft nickel steel, oil tempered and annealed, with Sanderson self-hardening steel tool.

The fourth and last experiment was with the same lathe, 36-inch x 25-foot Putnam, cutting nickel steel shaft, cut constant at ¼-inch deep and feed ⅛-inch per revolution. The speed of motor was gradually increased from No. 3 notch to No. 11 notch of the controller, representing an increase of motor revolutions from 220 to 700 per minute. The results are given in the following table and are also plotted in Fig. 10.

DATA FROM FIRST EXPERIMENT.

	Depth Cut.	Feed per Rev.	Turns per min.	Diameter Work.	Amperes.	Volts.	Revs. of Motor	H. P.	Watts.
1. Cutting.................	⅛"	1/16"	2¼	36½	3.4 Back gear connected.	222¼	353	1.15	756
2. Not Cutting............	..	..	..	..	1.8 Back gear connected.	228	...	.694	578
3. Light.....................	..	..	..	..	1.6 Back gear disconnected.	228	...	.49	364
4. Cutting.................	⅛	1/16	2⅕	42	3.4 Back gear connected.	221	346	1.07	757
5. Cutting.................	⅛	1/16	3¼	41	3.65 Back gear connected.	310½	510	1.52	1135

Ratio.—Revolutions lathe spindle to motor, 1 to 157.
Metal removed per hour, No. 1 experiment, 33,8 lbs.
" " " " No. 4 " 38.2 "
" " " " No. 5 " 54.8 "

DATA FROM SECOND EXPERIMENT

	Depth Cut.	Feed.	Speed Cut per min.	Speed Reverse per min.	Revs. of Motor.		Amperes.	Volts.	Watts.	H. P.
1. Cutting, two tools.	⅛	1/16	17.15	60	423	Reverse to cut....	15	237	3560	4.77
						Cutting	6.75	237	1602	2.15
						Reverse to return.	34.75	236	8210	11.
						Returning........	7	236	1655	2.22
2. Cutting..........	⅛	1/16	21.83	68.6	544	Reverse to cut....	16	304	4860	6.52
						Cutting	7	304	2160	2.85
						Reverse to return.	27	304	8210	11.
						Returning........	7.5	304	2282	3.06
3. Not Cutting.......	..	..	17.15	60	424	Reverse to cut....	16	238	3810	5.41
						Cutting	4.5	238	1072	1.437
						Reverse to return.	33	238	7790	10.45
						Returning........	6.5	236	1536	2.06
4. Not Cutting......	..	..	21.83	68.6	560	Reverse to cut....	16	304	4860	6.52
						Cutting	5	304	1522	2.04
						Reverse to return.	27	304	8150	10.95
						Returning........	7.5	304	2285	3.06

DATA FROM THIRD EXPERIMENT.

	Depth Cut.	Feed per Rev.	Diameter Work.	Revs. per min.	Amperes.	Volts.	Revs. of Motor	H. P.	Watts.
1. Cutting.................	5/32"	3/64"	9⅝	3 9/16	4 Back gears connected.	138.5	258½	.743	554
2. Not Cutting............	..	..	..	4.13	1.35 Back gears connected.	150	300	.272	202
3. Light.....................	..	..	..	4.25	1 Back gears disconnected	152	308	.204	152
4. Cutting.................	⅛	⅛	9¾	5.76	5 Back gears connected.	226	418	1.516	1130
5. Cutting.................	3/16	⅛	9¾	4.65	6.7 Back gears connected.	195.5	337	1.76	1310
6. Cutting.................	¼	⅛	9¾	3.28	7.3 Back gears connected	194	238	1.9	1418
7. Cutting.................	¼	⅛	9¾	2.71	8 Back gears connected.	117	196½	1.256	936

Controller Notch.	Depth Cut.	Feed.	Amperes.	Volts.	Revs. Motor.	Watts.	H. P.
3	¼	⅛	6.3	126.5	220	796	1.068
4	¼	⅛	6.1	156	277	950	1.276
5	¼	⅛	7.6	197	343	1500	2.01
6	¼	⅛	7.3	213.5	428	1560	2.092
7	¼	⅛	8.3	262.5	540	2182	2.92
8	¼	⅛	7	290.5	573	2035	2.73
9	¼	⅛	8.3	334.5	655	2780	3.73
10	¼	⅛	7.1	375	674	2675	3.57
11	¼	⅛	8.4	378	700	3180	4.26

It is unfortunate that there was not time to carry these experiments still further, that correct deductions might be made as to the actual power required to cut various metals at varying speeds for different types of machines. Those shown are hardly sufficient in themselves to determine this data with any degree of exactness; still it may complete or add to somebody's information, while they in their turn may supplement ours.

As a general deduction it would seem that the tendency is to place too large motors upon the machines to the sacrifice of efficiency, as they are seldom, if ever, run at their highest speeds. It is, of course, best to have motors of ample size, but we are so fearful of getting them too small that we err on the other side. Necessarily in a shop manufacturing general machinery of all sizes and description, motors for a certain lathe must needs be larger than in a shop manufacturing standard engines, etc. In the first case the lathe may be called upon to turn up work of all diameters, while in the second instance the diameter of the work will vary within the same limits, year in and year out. These factors must be taken into account in designing an economical plant. We hope to have the pleasure of putting before our readers in

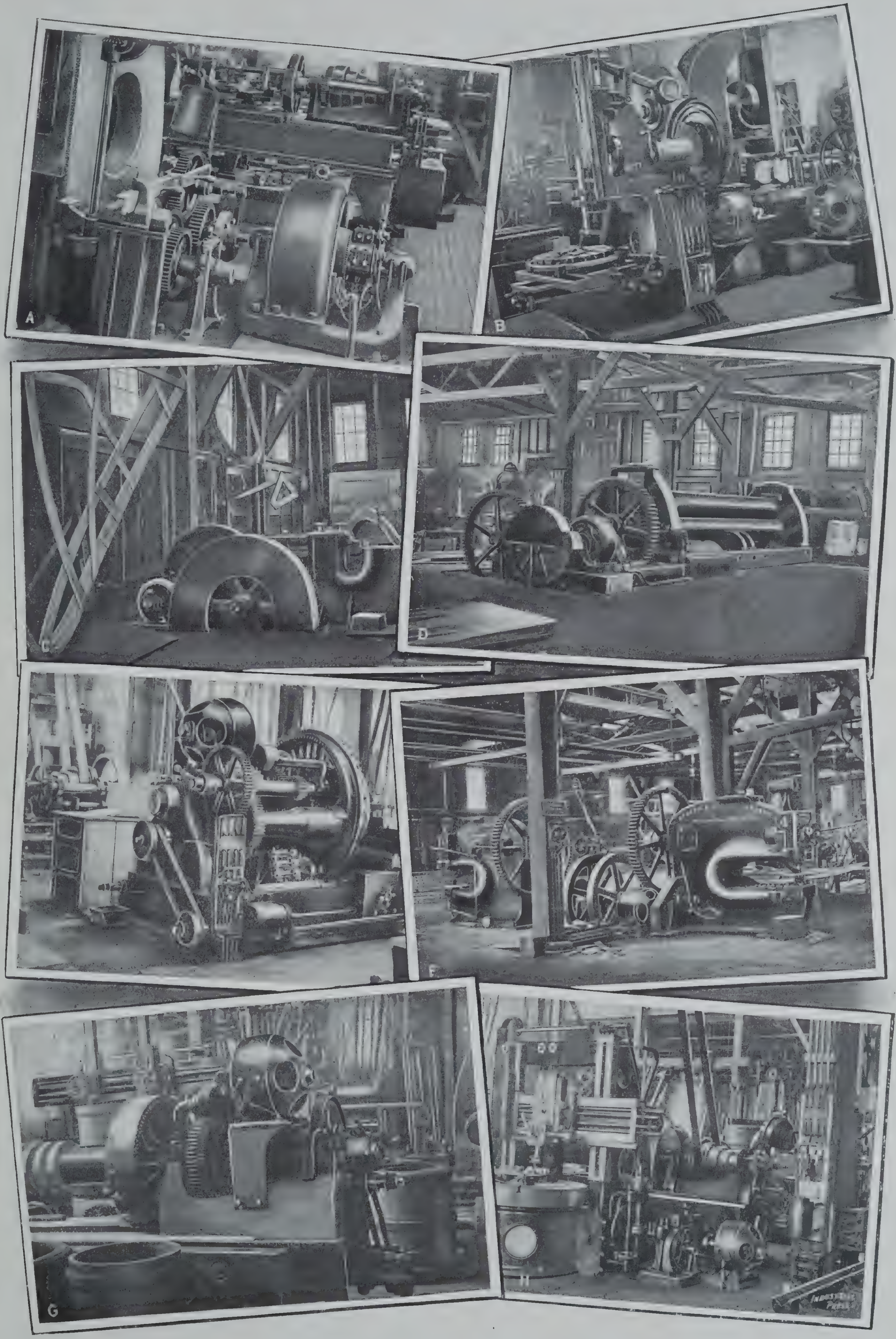
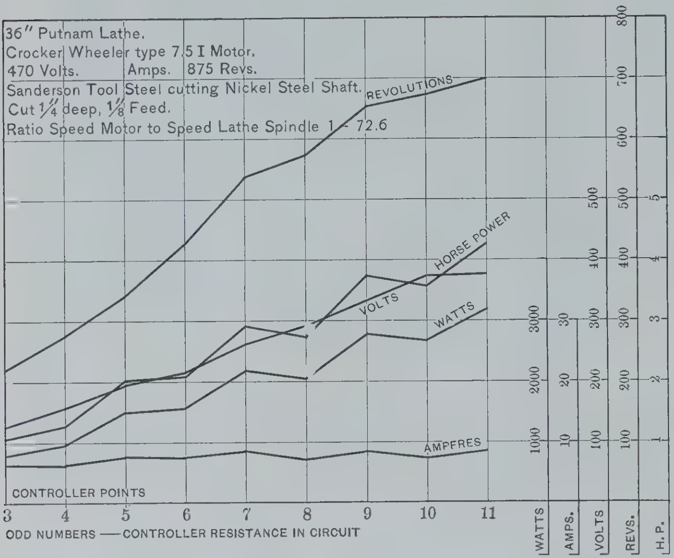


Fig. 9.

A.—Motor Drive for No. 7 Betts Boring Mill, 15 H. P. Motor.
B.—Betts 14-inch Slotter, 5 H. P. Motor.
C.—No. 3 Horizontal Punch, 7 1-2 H. P. Motor.
D.—Four 22-foot Bending Rolls—Driving, 35 H. P. Motor; Lifting, 10 H. P. Motor
E.—62-inch x 30-feet Putnam Lathe, 10 H. P. Motor.
F.—No. 4 Punch, 10 H. P. Motor.
G.—Back View 36-inch Putnam Lathe, 7.5 H. P. Motor.
H.—51-inch Baush Boring Mill, 7.5 H. P. Motor.

the future a systematic series of experiments of the capacities of type machine tools, under varying conditions, with tools of varying standard steels.

The table below gives a list of the principal tools, with their motors, as used in the machine shop.



Industrial Press, N Y

Fig. 10. Diagram showing Results from Fourth Experiment.

Power Required to Drive Shafting.

A paper read at the International Engineering Congress at Glasgow in 1901 by Messrs. James Crighton and W. R. Riddel contains some figures that are interesting in connection with our desire to learn the amount of friction and power necessary to drive line and countershafting. There were two main lines of shafting in the case under discussion. At the first trial, only the line shafting and loose pulleys were run. The machines and countershafts were run along with the shafting at the second trial and the final trial was made with the machines cutting at their normal rate. The average diameter of shafting was 3¼ inches; the average number of revolutions 140 to 150; the bearings were of white metal, self-oiling. The machine was 12 feet between centers. The total length of shafting in the works was 2,300 feet and its weight 37.42 tons of 2,240 pounds.

SPECIFICATIONS OF PRINCIPAL TOOLS, AND THEIR MOTORS.

MACHINE.	Size.	Motor.	Size.	H. P.	Revs.	Volts	Amperes.	Winding
Cincinnati D. H. Shaper	18″	C.-W.	3 I	3	975	470	5.75	Comp.
Pond Boring Mill	10′	C.-W.	20 D	20	775	470	36	Shunt
Newton Slotter	18″	C.-W.	7½I	7½	875	470	13.5	Comp.
Baush Radial Drill	No. 6	C.-W.	5 I	5	950	470	9.4	Shunt
Radial Drill	5′	C.-W.	5 I	5	950	470	9.4	Shunt
Newton Slotter	14″	C. W.	5 I	5	950	470	9.4	Comp.
Woodward & Powell Planer	36″ x 12′	C.-W.	15 I	15	840	470	28	Comp.
" " "	36″ x 12′	C.-W.	15 I	15	840	470	28	Comp.
" " "	36″ x 16′	C -W.	15 I	15	840	470	28	Comp.
Gray Planer	56″ x 56″ x 12′	C.-W.	20 I	20	775	470	36	Comp.
Woodward & Powell Planer	30″ x 30″ x 8	......	10 I	10	850	470	18.5	Comp.
Mitts & Merrill Keyseater	No. 5	C.-W.	3 I	3	975	470	5.75	Comp.
Newton Cold Saw	......	C.-W.	5–I	5	950	470	9.4	Comp.
Newton Floor Boring Machine	No. 1	C.-W.	7.5 I	7.5	875	470	13.5	Shunt
Newton Duplex Rod Boring Mill	......	C.-W.	1	1	950	470	2	Series
....	......	C.-W.	7.5 I	7.5	875	470	13.5	Shunt
Shaft Lathe	38″ x 44′	C.-W.	7.5 I	7.5	875	470	13.5	Shunt
Newton Duplex Boring Machine	......	C.-W.	7.5 I	7.5	875	470	13.5	Shunt
Niles Horizontal Boring Machine	......	C.-W.	15 D	15	800	470	28	Shunt
Duplex Milling Machine, Newton	No. 4	C.-W.	10 I	10	850	470	18.5	Shunt
Doublehead Shaper	......	C.-W.	3 I	3	975	470	5.75	Comp.
Betts Boring Mill	7′	C.-W.	....	½	1200	470	1.1	Series
" " "	7′	C.-W.	15 D	15	800	470	28	Shunt
Betts Slotter	10″	C.-W.	3 I	3	975	470	5.75	Comp.
Baush Boring Mill	51″	C.-W.	7.5 I	7.5	875	470	13.5	Shunt
Acme Bolt Cutter	No. 1	C.-W.	7.5 I	7.5	875	470	13.5	Shunt
Planer	42″ x 42″ x 20′	C.-W.	15 I	15	840	470	28	Shunt
Dallett & Co. Portable Deck Planer	......	......	....	5	...	470	7	......
Putnam Lathe	62″ x 30′	C.-W.	10 I	10	850	470	18.5	Shunt
" "	36″ x 25′	......	7.5 I	7.5	875	470	13.5	Shunt
For Boring out Shaft Struts	......	C.-W.	7½ I	5	975	470	9.3	Comp.

The engine indicated 61.75 I. H. P. on the first trial; 141 I. H. P. on the second trial, and 310 I. H. P. on the third trial. From these powers it will be seen that the line shafting absorbed 29.3 per cent. of the total power; the machine and shafting 67 per cent, and that only 33 per cent. was applied to the removal of the material by cutting, planing, shaping, etc. These figures show the large proportion of power that is lost in keeping the system in motion and the absolute need of individual motor drives; for if but one or two machines are being used, this percentage of loss would be much greater, as this main line shaft friction is a constant quantity whether one machine or the machinery of the entire plant is being operated.

It will be understood that every machine need not be separately driven, as in many cases it is preferable to use the group system—that is, the use of a 15 or 20 horse power motor, driving several medium or small tools. This necessitates a short length of line shafting, but the friction is so small and the convenience so great that it is by far the best way. Another reason is that we have the advantage of the better efficiency of the large motor as compared with the lesser efficiency of the small ones. The cost is much less also, as we have one motor against five or six small ones.

* * *

EFFECTS OF ALUMINUM ON IRON AND STEEL.

The effects that small amounts of aluminum have on the different forms of iron are of great importance. It was discovered by Wittenstrom in the 80's that, if 0.05 to 0.1 per cent of aluminum was added to a charge of wrought iron heated to pastiness, the iron liquefied so that it could be poured. The castings called Mitis castings have properties similar to wrought iron, excepting that they lack the fibrous structure.

In making steel castings, an addition of 0.03 to 0.05 per cent. of aluminum has a very beneficial effect in reducing the small amounts of iron oxide that are formed, especially in pouring. The elimination of oxides makes the steel more tough, and by preventing the oxides from oxidizing some of the carbon of the steel, it hinders the evolution of carbon monoxide, which, stirring up the steel, causes the expulsion of occluded gases. It thus diminishes, if it does not prevent, the formation of blow-holes.

The effect of 0.01 to 0.05 per cent. of aluminum upon cast iron is to convert some of the combined carbon into graphitic carbon. It is mentioned here in connection with wrought iron and steel as the third form of industrial iron. A satisfactory explanation has so far not been offered.—F. O. Hofman in *Technology Quarterly.*

STEEL AND ITS TREATMENT.—1.

HEATING FOR HARDENING.

E. R. Markham.

If men engaged in the different branches of shop work would perfect themselves in their particular lines, and in this way convince those who employ them that they are proficient workmen, they would, by so doing, make themselves indispensable.

"But," said one young man to whom I was talking about taking up a course of evening study, "I work hard all day and I don't care to study all night. When I get out at six o'clock I want a little recreation; so I go down town with the boys. I shan't be young but once you know." I told him he would be old once, and asked him to seriously consider this fact and that the money he spent evenings with the boys would purchase the necessary books to study; or would pay for a course of study in some correspondence school. His answer was: "I never spend more than 10 or 15 cents of an evening, and that is little enough. Why, Smith spends from 25 to 50 cents every night, and I could tell you of lots of boys in our crowd who spend *more* than that." And he tries to justify his own actions by mentioning others worse than himself.

An experience of years in charge of large numbers of men has convinced me that it is not of much use to talk to the "*old fellows*" whose habits are fixed. I wish to say a few words to the *young man* just starting to learn the trade that is to fit him to fight life's battle; and to the man—be he young or middle aged—who has an ambition to be somebody, and realizes that he depends on his own efforts to reach the goal. And by the way, when it is apparent that a man is trying to help himself, some one is generally found who will take an interest in him and try to help him. I hear young men say: "What is the use of studying and working every minute trying to reach the top of the ladder? If everyone did that, the top wouldn't be large enough to hold them all." As long as a great proportion of our young men feel and talk that way, however, there is no great danger that the top rounds of the ladder will be seriously affected by the weight they have to sustain. And the chances are good for the man who is willing to sacrifice a little time each week in order to broaden his mind and learn things that will be of benefit to him in the future.

At the present time when libraries are accessible to nearly everyone, and when books and mechanical journals treating on nearly every branch of the machine business can be obtained so cheaply, there is really no excuse for the man who does not better his condition. And in no branch of machine shop work is there a greater field for study and advancement than in that of hardening and tempering steel.

The past twenty-five years has witnessed great changes in the designing of machinery. Lathes, planers and milling machines have been changed not only in design but by the addition of metal to so strengthen them that heavier cuts can be taken and faster feeds used than were dreamed of thirty years ago. Now in order to have these machines do the maximum amount of work it has been necessary to make stronger and heavier fixtures. Cutting tools have also been changed and made much stronger. But if these tools are to do the amount of work the machines are capable of producing, it is very essential that they be hardened *properly*. I am convinced that very few manufacturers realize the amount of money lost in their establishments every month because cutting tools are not properly hardened, and are thus incapable of turning out as much work as they otherwise might. Some manufacturers are looking for men who can do this class of work in a *satisfactory* manner; and their number will increase as they realize the enormous leak through this one source, and the demand for competent hardeners will be greater than the supply.

In order to become a successful hardener, one must understand the characteristics and the nature and peculiarities of steel. These can best be learned by an intelligent study of works treating on these subjects. Tool steel is manufactured with the idea in view that it is to be used to make tools that must be hardened in order to do the work expected of them. All makes of tool steel are not adapted to the same class of tools. Many times a mistake is made in buying steel, say, to make fine-edge tools, because some one had good success with this particular make when using it for railroad track chisels. As the man using the steel has very little to say about the buying of it, I shall not say what particular brand of steel is best for this or that purpose; but I shall endeavor to give the reader such advice as should enable him with a little practice to get good results from almost any make of steel.

Any tool steel commonly used in machine shop work has a surface which is somewhat decarbonized from the action of the oxygen in the air acting on the carbon near the surface of the bar, during the various processes through which it goes, in the rolling mill and forge shop. Consequently it is necessary to select steel enough larger than finish size of the tool to be made, to allow of the removal of sufficient stock to get below this portion, or the piece when hardened will have a *soft* surface. Or if not soft the surface will not be as hard as the balance of the piece. When centering tool steel it is necessary to have the centerpunch mark in the *center* of the piece, as indicated in Fig. 1. If centered as shown in Fig. 2 a larger portion of the decarbonized surface will be removed at *a* than at *b*. As a result the side from which the greater amount of stock was removed will be the hardest; and as steel contracts when hardening, if one side is harder than the opposite side, the contraction of the two opposite sides will be unequal, consequently the piece must spring.

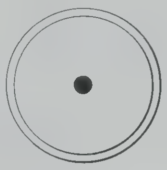


Fig. 1.

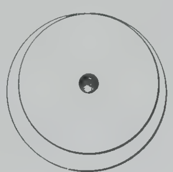
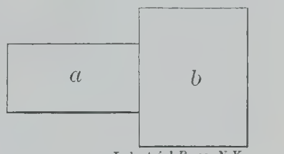


Fig. 2.



Industrial Press, N.Y.

Fig. 3.

Every man and boy working in a machine shop knows that tool steel is hardened by heating until red hot and then plunging in some cooling bath. But a great many are not thoroughly posted as to the best methods of procedure to get the best results. In order to heat steel properly one must understand the peculiarities of the particular steel he is using. All steels are not affected alike by the action of heat. Some makes of steel will harden at an extremely *low* red heat, and give the best results if heated in this manner; while others require a higher heat in order to harden at all. One brand of steel I have in mind gives excellent results if heated for hardening in some manner that excludes the air from the steel; but if a tool which cannot be ground on its outer surface—as a tap or formed milling cutter—be made of this steel and exposed to the action of the air when heating, the surface carbon will be given off to such an extent that the outer surface will be soft, rendering the tool unfit for use. Yet these same tools if heated in a muffler furnace, or in a piece of gas pipe, or tube, in the open fire would be very satisfactory. In fact, *any* steel is better if heated for hardening as described above; but all steels are not so sensitive to the action of the air as the one mentioned.

I remember having in my employ in a large tool room at one time, a young man who, when he had a tool to make whose shape betokened trouble in hardening, would ask permission to harden the tool himself. This privilege was always granted, as he showed a desire to learn. While the machine at which he was working was running, he would cut a thin piece of steel from the end of the bar from which he had cut the piece for the tool. This he would heat in a furnace in the tool room and then harden, being very careful in heating not to get it any hotter than was necessary, according to his judgment. After drying thoroughly he would examine it for hardness. If he considered it hard enough he would break it and examine the fracture.

He would then bring it to me and tell me his opinion of the steel and of his heat, asking me to give him any information possible on the subject. Is it necessary for me to say that to-day that young man is holding a responsible position in a large manufacturing establishment? The desire he had to know the *whys* and *wherefores* of every job he had anything to do with, gave him an impetus to study and work, and it was a positive pleasure to give him any information possible.

But to return to the heating of steel for hardening. Although steel should never be given a higher heat than is necessary to produce a desired result, an uneven heat is much more detrimental to steel than an even heat which is a trifle too high. In order to get good results when hardening, the piece must be heated uniformly throughout, the corners and edges must not be hotter than the center, and the interior of the piece must be of the same temperature as the outside; otherwise the piece will be almost sure to crack when dipped in the hardening bath. If a piece of steel is heated hotter than is advisable for hardening—yet not hot enough to burn it—lay it one side, and allow it to cool. Then it may be reheated to the proper temperature and plunged in the bath. The effect of a high heat is to open the *grain* of the steel, making it porous. In this condition it is very brittle, and on account of the separation of the atoms that go to make up the piece of steel, it will be incapable of doing the amount of work it would if the grain were compact, as the minute holes or pores between the atoms of steel allow the surface of the tool to break away. The reheating of the piece has the effect of closing the pores and of making the grain compact, thereby furnishing a solid backing for the cutting edge.

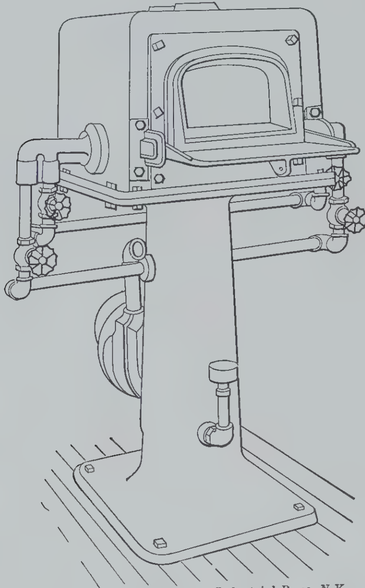

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Fig. 4.

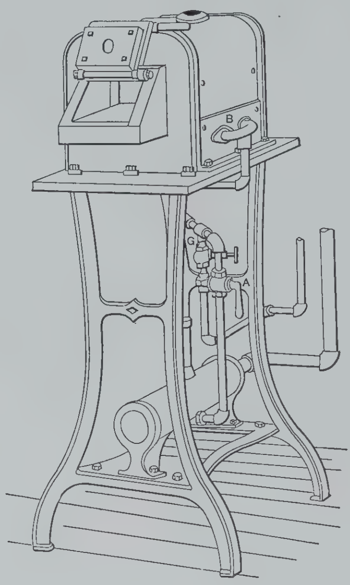

Fig. 5.

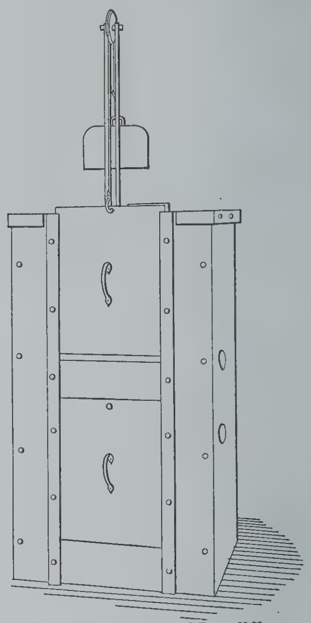
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Fig. 6.

A method that is wrong, but nevertheless often adopted by shop men when a tool is heated too high, is to allow it to cool in the air until it appears "about right" and then to dip it. The grain is then as open as if dipped at the high heat, and the unequal heat—too hot inside and cooler at the surface—would cause unequal contraction of the outer and inner portions of the piece, thereby causing it to crack. It is *unequal* contraction when cooling that causes a tool of the shape shown in Fig. 3 to crack at the shoulder when hardened. Heat has the effect of expanding steel, while cooling contracts it. A piece of steel which is expanded by heating, if suddenly cooled (and thereby contracted) is subjected to a very great strain. Now if one portion of Fig. 2, as *a*, is smaller than *b*, then *a* will, of course, contract faster than *b*. And if *a* hardens way into the corner or to the shoulder before the larger portion was through contracting a crack must be the result. This would be especially true if the two diameters were unevenly heated. But the larger shoulder containing more heat than the smaller diameter communicates *its* heat to the corner, keeping that from cooling as rapidly as the balance of the smaller portion and preventing cracking at that point. Uneven heating is probably the cause of more steel being ruined than any other one thing. While it is advisable to heat steel as quickly as possible consistent with uniform heating, yet it should never be heated so fast as to produce uneven heats.

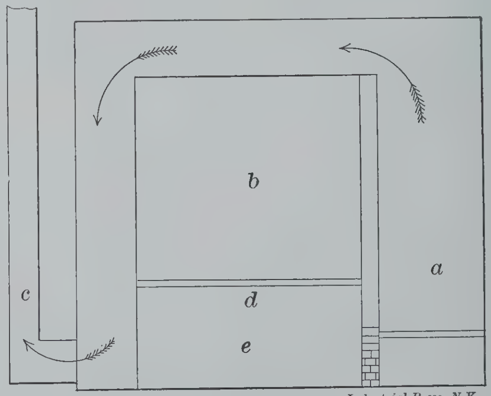

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Fig. 7.

It is, of course, very desirable to have in a hardening room the best equipment obtainable. Generally speaking, however, men are obliged to use the equipment furnished by the concern employing them. Everything being equal, a man having access to a good muffler gas furnace, and the most approved baths can do better work than one who is obliged to use an ordinary blacksmiths' forge having a leaky tuyere, and whose only bath is a greasy pail filled with water of an uncertain quality. Yet it is a fact that the *successful* men in our shops are men who make the best of conditions as they find them. Now, if a man finds the conditions as stated, he can build a large, high fire, and by placing the article to be hardened in a piece of pipe or other receptacle, so that the fire and air from the blast cannot strike it, he can by frequently turning and moving the piece, get a very uniform heat. He can also empty the pail, wash it out and fill it with clear water. Years ago I was making tools in a small shop that had just been started, where there was no furnace of any description and no means of heating a piece of steel. I made six sets of small form milling cutters. The proprietor proposed sending them to a blacksmith to be hardened, but I asked the privilege of hardening them, which he granted. I took them home, and heated them in the kitchen range, putting them one at a time in a small iron box I had in the house. I placed about ½ inch of powdered charcoal in the box before putting in the cutter and while the cutter was heating I covered the box with a piece of sheet iron. When the cutter had reached an even low red heat, I took it from the box with a hook and plunged it in a pail of water containing a small quantity of salt. After hardening the entire lot they were brightened and the temper drawn. In order to do this I inverted the box in the fire, placed the cutters on the bottom of the box, and by frequently turning them I got a very satisfactory temper, as they were not very thick. I mention this incident to show that under trying circumstances a man may, by using his wits, do a very satisfactory job. Although I have since then hardened many pieces worth hundreds of dollars each, I do not think I have ever done a job of hardening that was a source of greater pride than those milling cutters, hardened under the difficulties mentioned.

The heating of steel is very important and a great deal depends on the facilities for doing a good job in a reasonable amount of time. There are several forms of hardening furnaces in the market which give excellent results. Figs. 4 and 5 show two kinds using illuminating gas as fuel, which are both of the form known as muffler furnaces, because the work is heated in an oven, or muffler. The flame circulating around the muffler does not come in contact with the steel and one obtains much better results than if the work were exposed to the action of the products of combustion in the fire. But if so situated that one cannot have a furnace of the kind shown, it is possible to make one that will do excellent work. Still I doubt the economy of making one when it may be bought so cheaply of some reliable maker.

If the gas rates are reasonable in the city in which the shop is located, a gas hardening furnace will be found the cheapest form to use. They are certainly the most satisfactory. But if the gas rates are so high as to make this sort of furnace impracticable, a very excellent form of coal-burning furnace, of the form shown in Fig. 6, may be procured, or one as shown in Fig. 7 may be used. This furnace will burn either charcoal or hard coal. It consists of a firebox *a* and a muffler *b*, the flame and heat passing up the side and across the top of the muffler in the direction of the arrow. It then passes down the opposite side of the muffler to the smoke pipe *c*. The grate *d* should be made of a form that allows of the easy removal of clinkers and ashes. The ash box *e* should be provided with a door having draft holes, which may be closed or opened to furnish the desired amount of draft. There should also be a damper in the smoke pipe in order that the draft may be checked at will. The muffler should have a door, through which should be drilled one or two holes. These should be covered with isinglass, in order to exclude the outside air, yet furnish a means whereby the condition of the work may be seen when the door is shut.

It should be borne in mind that it is not advisable to heat tool steel in an ordinary *coal* fire unless some means is provided whereby the fire will not come in contact with the steel, as the sulphur in the coal has a very injurious effect on the steel. In the furnace described above, the work being in the muffler is entirely removed from the action of the fire, the heating being done by radiation.

A piece of tool steel that is to be hardened should never be straightened *cold*. If the piece is bent too much to turn out and allow of removing all the decarbonized portion at all points, it should be brought to a red heat and straightened. If a piece of stock should spring in annealing it should not be straightened *cold*, that is, if it is to be hardened afterward.

When making costly tools from a bar of steel that has not been tested, it is advisable to cut a small piece of stock from the bar, heat it very carefully, dip in the bath, and then test it with a file for hardness. After drying thoroughly it should be broken as nearly across the center as possible, the grain examined, and by aid of a magnifying glass it should be examined also for traces of piping. If the steel is piped the bar should be returned to the steel mill before there is any chance of an expensive tool being made from it.

"A pipe," according to Metcalf, "is the cavity formed in an ingot when it cools; the walls chill first and nearly to the full size of the mold, then the shrinking mass separates in the middle, forming a pipe. A pipe should be at the top of the ingot; it may occur anywhere by bad teeming. This cavity, or pipe, may extend through the entire length of the bar, rendering it unfit for general use. A make of steel should not be condemned, however, because a bar containing a pipe is discovered. This is liable to happen to any steel. It is closely inspected at the mill, but sometimes escapes even the closest inspection, and the steel maker will willingly replace the piped steel with a sound bar.

BLANKING DIES.

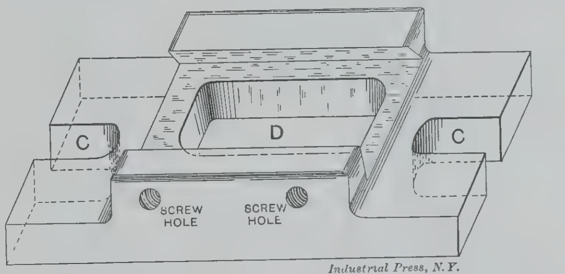
MAKING AND USING "DOUBLE" OR PIERCING AND BLANKING DIES.

Joseph V. Woodworth.

When ordering steel for dies, annealed steel should be specified, as the saving of time and labor and the superior results that will be obtained in hardening and tempering the finished tools will be a source of gratification to the diemaker. When these results are taken into account the slight extra cost of annealed steel is insignificant. As to the grade or brand of steel to use, be sure to get a good grade, and as there are several brands of steel on the market which are used principally for dies, no difficulty should be experienced in procuring a grade which will prove suitable for any special class of work. When steel forgings are required the job should be given to a smith who understands this branch of his art, for, in order that the forgings shall machine well and be hardened and tempered so that the finished tools will work satisfactorily, the smith must understand such work.

Die Block or Bolster.

Before taking up the description of the die we will devote a short space to the die block or bolster. Although these bolsters are made in a variety of shapes and sizes, the one shown in Fig. 1 is of the type most generally used for fastening and locating the class of dies indicated, while in Fig. 2 are shown a number of other styles used for dies of the same class. A large number of shops make a bolster for each die, so as to leave the tool permanently within it, but for economy, where dies for producing blanks of an average shape and size are used, two or three are all that are required.



Industrial Press, N.Y.

Fig. 1. Bolster for Holding the Die.

In machining the bolster a cut should first be taken off the bottom and then the face planed dovetail to an angle of 10 degrees, this being a standard among diemakers. The slots *C C*, Fig. 1, are cast in width sufficient to allow of clearance sideways for the fastening bolts, with which it is afterward secured to the press bolster. The hole *D*, in the center, should be made large enough for the largest blank—from the set of dies which are to be used in this bolster—to drop through after being punched.

Double Punch and Die.

In Figs. 3, 4 and 5 are shown a double punch and die used for the production of blanks like Fig. 6. The punch and die consist of the following parts: The punch holder or stem *A*, Fig. 4, of cast iron, the punch plate or pad *B* of mild steel, the blanking punch *C* of tool steel, the piercing punches *D* of the same, the stripper and gage plate *E*, the die *F* of tool steel and the pilot pin *G*. The shape of the piece to be produced in a die of this type may be any circular or irregular shape desired, as the method of construction here described is applicable to all, excepting when the blank to be produced is very large in size or when the metal punched is very thick. Fig. 8 shows different shaped blanks produced in dies of the above construction.

As most presses in which punches and dies of this class are used require a punch-holder with a round stem, one of this sort is here shown. When machining the holder great care must be taken to get the working surfaces square with the stem; also the faces of the punch plate and stripper plate must be perfectly parallel. When planing the die no great care is required, as it has to be ground after hardening. It should be finished with beveled sides to fit the bolster, with the edges of the face smooth, so as to have a square edge from which to lay out the die. Lay the punch plate, punch-holder and stripper plate aside, as they will not be touched until the die proper has been finished.

The Use of Templets.

Now in order to lay out the die a templet or master blank is required. It should be made from sheet steel about 3-32 inch thick, and should be filed and finished all over to the exact shape of the blank and be the size required. The two holes should then be laid out in the exact location desired, and then drilled and reamed to size. Care and accuracy in the preparation of the templet are necessary, as the quality of the work to be produced depends on it. Now take a piece of, say, ⅛-inch brass rod about 2 inches long and solder one end of it to the back of the templet as shown in Fig. 6. The templet is now complete and there is no possibility of getting the wrong side up.

Take a piece of soft sheet brass, of the same thickness as the male templet, and bend it to the shape shown in Fig. 7; that is, to fit across and over the face of the die, with the bent ends projecting down the inclined sides of the die about 5-16 inch. This is the female templet, and it should be worked out in the center to fit the male templet. After this has been done the face of the die should be polished with rough emery cloth and "blue-stoned," the female templet placed upon it, in the proper position, and an outline of the blank marked through it on the face of the die with a sharp scriber. Now remove the templet and proceed to finish the blanking die, which is accomplished by working the blank through it.

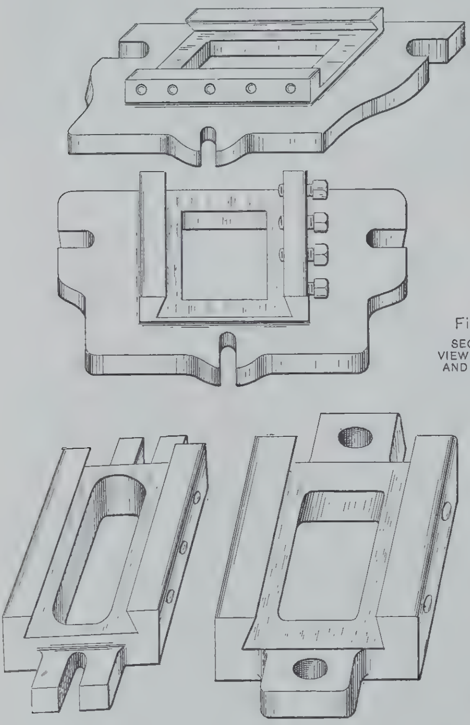
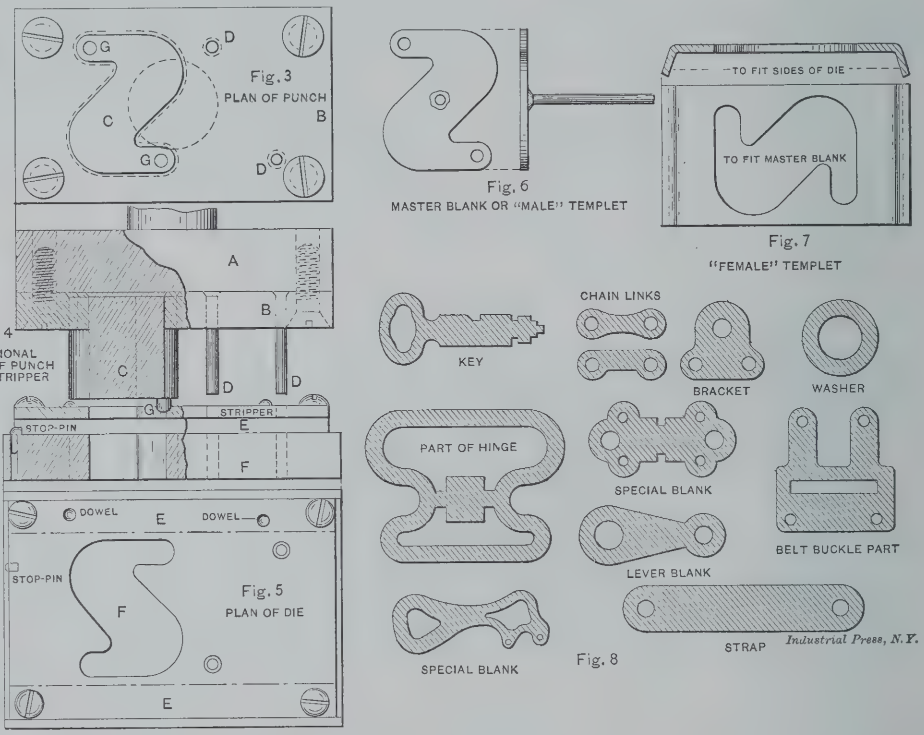


Fig. 2. Different Types of Bolsters.



Figs. 3 to 8. Double Punch and Die, Templets and Characteristic Blanks.

To work a templet through a die proceed as follows: After the surplus stock has been removed by drilling holes about 1-32 inch apart around the inside of the outline and then drifting it out, file through from the back to within a shade of the line. Now take the male templet and, holding it by the end of the brass rod, enter it into the die from the back, holding it as parallel as possible with the face of the die. By holding a piece of white paper in front of the die it will be seen that the die touches the templet at only a few narrow spots. Take a lead pencil and mark these spots, making a line at each spot as long as the surface touched. Now remove the templet and file where the marks appear. Keep inserting the templet, marking the spots, and filing them away, and in a surprisingly short time the templet will be at the top of the die, which will then be the exact shape and size desired, fitting the templet perfectly.

Clearance.

There are a great many dies of this type used (for blanking out stock which is not required to have smooth sides) in which it is not necessary to finish the insides smoothly; but there are a greater number in which the finish of blanks with smooth sides is one of the objects sought. In dies for producing smooth and well-finished blanks the insides should be finished highly, either with a dead smooth file or a scraper.

In giving clearance to a die a few things must be considered in order to decide upon the proper amount to give. For a die which will only be used to produce a few thousand blanks excessive clearance should be given, say, 5 degrees, as this will allow of the die being finished quickly. In dies which are required to produce large quantities of blanks, and in which the blanks produced are desired to be approximately the same shape and size, 1 degree is plenty. As the die will have 1 degree of clearance all the way through, the holes drilled in the process of removing the stock should be reamed from the back with a reamer tapered to from about 1-32 inch to 1 inch of length. The reaming of the holes when constructing a blanking die will save a vast amount of filing, and the giving of the 1 degree of clearance will not be difficult.

The next step in the construction of the die is the locating of the two piercing holes. To accomplish this, place the male templet within the female and clamp it to the face of the die in the correct position, allowing for a thickness of metal between the blanks. Now take a center drill which fits the holes in the male templet and transfer the two holes through it to the face of the die. Drill these holes and then ream them from the back with a reamer of the same taper as the one used for the blanking die. After the holes for the dowel pins and screws, with which the stripper and gage plate are to be located and fastened on the die face, have been drilled and tapped and the hole for the stop pin located and drilled the die is ready to be hardened and tempered.

Hardening a Blanking Die.

In order to harden a blanking die properly great care should be taken, first, in the heating of the steel, and, second, in the quenching. In all shops where dies or other tools that require hardening are constructed a gas furnace or "muffler" should be used for heating them. But when a "muffler" is not handy charcoal should be used. After a good clean fire has been built all screw and dowel holes should be plugged with fire clay or asbestos. By taking these precautions the tendency of the steel to crack around the holes is, as far as possible, eliminated. The steel is now heated to an even cherry red, so that the entire surface will be the same heat. Then it is removed from the fire and dipped straight down, endwise, into the water, which should first be warmed slightly to take off the chill. Care should be taken to dip straight and not to move it or shake it around, as that will increase the possibility of the die warping or shrinking excessively. After removing the die from the water it should be immediately warmed. Now grind the face of the die, heat a piece of heavy cast iron red hot, place the die upon it, and it can then be drawn evenly to the temper desired. By taking a piece of oily waste and wiping the face of the die as it is heating the different colors will show up clearly. When the color denoting the temper required appears remove the die and allow it to cool off slowly.

Finishing the Punch.

Now for the blanking punch. Take the blank, or male templet, remove the wire rod and mark the spot where it was attached so as to know the back from the front of the blank. Then solder the blank, front out, to one end of the piece of steel which is to be used for the blanking punch. The punch can now be machined, either in the shaper or in the milling machine, so that its entire length will be the shape of the blank, finishing it as close to the edges of the templet as possible. Now heat the punch slightly and the templet will drop off. Clean the blank, lay it aside, and proceed to fit the punch. If it is to punch very thin stock make it a tight fit within the die; if for heavy stock, a trifle loose. In order to make a punch a perfect fit, so as to punch thin stock cleanly, the edges of the cutting face should be beveled with a file and the punch should then be sheared through the die in the press, in much the same manner as a broach is used, being careful to have it in perfect alignment with the die. This shearing of the punch should be accomplished progressively, first forcing it in about 1/8 inch, then removing it and filing away the curled up metal, and repeating this until the punch has been forced completely through the die. While doing this use plenty of oil on the parts.

Before hardening the punch—that is, if it is to produce accurate work, for in most cases it should be left soft—it is necessary to locate the holes for the pilot pins *G*. These pins are necessary in order to produce pierced blanks that will be interchangeable. Take the male templet and enter it into the die from the back, with the front up. It will fit the die tightly because of the shrinkage in hardening. Now enter the blanking punch from the top and locate the holes for the pilot pins through the holes in the blank with the same center drill used for locating the piercing dies. Drill the holes to size and then harden and draw the punch to the temper desired, which in most cases should be a dark blue. In tempering the punch draw it from the back, allowing the temper to run out to the face, and thus the back will be soft while the remainder will be as hard as required. The drawing of the punch so that the back will be soft is done to strengthen it and also to allow of upsetting it when locating it within the punch plate.

Aligning the Parts.

To locate the blanking punch in the punch plate, take the plate and clamp it true on the face of the die and then transfer the outline of the blanking die to the punch face. Then work a hole of the shape of this outline through the plate so that the punch can be entered face first through from the back. Place both punch and punch plate under the ram of the press, set the punch dead square with the face of the pad and proceed to force it through, using the punch as a broach to finish the hole. It will be found necessary to repeat this operation several times in order to get the punch through the plate, as the surplus stock curled up by the punch will have to be removed. After having forced the punch into the pad until the face is through, force it back and out again. Now chamfer the edges of the hole at the back of the plate and force the punch in again, until the back is a shade above the plate; then upset or rivet as shown and finish flat with the plate, and there will be no danger of the punch pulling out when in action.

To locate the holes for the piercing punches, enter the blanking punch into the die until the faces of the punch plate and the die are within 3-16 inch of each other, with a pair of parallels between them. Then use the die as a jig and locate holes for the piercing punches, spotting these deeply. With a drill about two sizes smaller than the piercing dies, drill entirely through the punch plate and then ream the holes to size. Use the die as a jig for all three operations. For the two piercing punches use drill rod or Stubbs wire and upset the heads before hardening, as all small piercing punches should be hardened for their entire length, otherwise they will bend or break when passing through the stock. If, after hardening, the punches are found to have sprung, they must be carefully straightened before forcing them into the punch plate. Fasten the punch plate to the cast-iron holder *A* with four flat-head screws, as shown in Fig. 4.

All holes for screws and dowels in the stripper plate should be transferred through the die. The holes for the two piercing punches should be the same size as the dies, and must be transferred, drilled and reamed through the dies after the plate has been located and fastened. By having the piercing punches fit tightly within the stripper they will be strengthened and supported while piercing the metal. The hole for the blanking punch may be a loose fit for the punch. After the gage plates and stripper have been located and fastened upon the die, as shown, with the stop pin located so that its locating face is the same distance from the edge of the blanking die as the width of surplus stock allowed between the blanks, the die will be complete.

The practical points to be kept in mind when constructing a die of the above type are: Be sure to make an accurate pair of templets. Machine the punch-holder, the pad and stripper plate accurately. Work the blank through the die and use it in locating all the holes for pilot pins and piercing dies. Finish the die before starting on any of the other parts. Transfer all holes in the punch plate through the die, and, lastly, be sure to have the front of the male templet up during all operations in which it is used. By keeping these practical points in mind you will have a punch and die in which the alignment between all parts will be perfect.

Setting the Die and Using it.

To operate the die drive it into the die block or bolster, Fig. 1, and then set it up in the press. The proper way to set a die of this kind is to first place the punch within the ram of the press and fasten it there. The punch should then be brought down until its face is within 3-16 inch of the die face. Then, using the left hand through the press bolster, the die should be raised up until all punches have entered it. The punch should then be brought down, by moving the press flywheel with the right hand, about 5-16 inch, and the die will rest squarely on the press bolster in perfect alignment with the punch. Now fasten the die to the press, give it a rap with a hammer at each end and go ahead.

The stock to be punched should be entered beneath the stripper and pushed up against the stop pin. At the first stroke of the press the two holes will be pierced and a "scrap" blank punched out. Now feed the stock forward until the back edge of the punched hole rests against the stop pin, and at the next stroke, as the punch descends, the pilot pins in the blanking punch will enter the holes pierced at the first stroke and a blank will be produced which will be an exact duplicate of the male templet. The stock may then be fed along until the entire strip has been worked up.

* * *

In astronomical work it is of the greatest importance to be able to read the graduated circles with the attached microscopes without bringing near the circles the source of light. Any light that we are now able to produce is accompanied by heat, and heat even of small degree locally applied, will quickly distort the circles so that accurate readings are impossible. To overcome this difficulty, Professor Becker, of Glasgow University, has recourse to solid glass rods to convey light to the graduated circles. Light projected into one end of a glass rod such as he uses, is delivered at the other end, even if the rod is curved. The light cannot escape from the sides on account of the internal reflection from the sides. The heat conveyed with the light, is, of course, of little proportions. To illustrate the sensibility of such graduated circles it may be mentioned that the radiation of heat from the human body has been found to exert a most sensible effect. So if it is necessary for an attendant to be near a circle, he or some one to take his place must remain in the same approximate position constantly throughout an observation.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY
Design—Construction—Operation.
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
9-15 MURRAY STREET, NEW YORK CITY.
CHICAGO—1462 MONADNOCK BLOCK. BOSTON—620 ATLANTIC AVE.
PHILADELPHIA—MACHINERY FLOOR, THE BOURSE.

SUBSCRIPTIONS.
SHOP EDITION, $1.00 A YEAR. TEN CENTS A COPY.
ENGINEERING EDITION, $2.00 A YEAR. TWENTY CENTS A COPY.
FOREIGN EDITION, $3.00 A YEAR PREPAID.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

SEPTEMBER, 1902.

NET CIRCULATION FOR AUGUST, 1902,—25,724 COPIES.

Mr. George H. Hall has been engaged as Associate Editor on the staff of MACHINERY, his work beginning with the October number. This addition to the editorial force will enable us to materially strengthen the machine shop features of the paper and we shall make the dollar or shop edition more valuable to the practical machinist than ever before. Mr. Hall is well equipped for his position by technical training and some eight years' varied experience in machine shop and drafting room, as well as by occasional work which he has already done on MACHINERY.

* * *

EIGHT YEARS.

The eight years which comprise the life of MACHINERY cover a period of unexampled prosperity to manufacturers; and while the growth of the paper has been unusual in the history of trade publications, it has not more than kept pace with the progress of the trade it represents.

Firms that were not in existence eight years ago, to-day own and operate plants employing hundreds of men, the establishment of which heretofore represented the toil and saving of a generation, and the extension of existing plants has progressed in a like degree. One entire section of Cincinnati—a city in itself—devoted almost entirely to the manufacture of machine tools and comprising twenty-one plants, some of the largest in the country, has sprung up in the period referred to. And it is also true that the rewards of skill and energy during that period have not been limited to the employer; for among the writer's personal acquaintance are many instances of mechanics who were earning day's wages less than eight years ago, who now control enterprises which represent the investment of good-sized fortunes. Yet the development in machine tools and kindred lines in this country has hardly more than begun, for the multiplicity of enterprises which rely for their progress and profits on the use of improved machinery offer rewards that will continue to spur on the ambitious mechanic; and although the present period of prosperity cannot continue without interruption, it is not probable that any one now living will witness the surrender by this country of the lead it has acquired in the design and manufacture of labor-saving appliances.

This is not a special number of MACHINERY, although it contains more advertising than usual. No canvass was made to obtain additional business for the September number, because we wished it to be a fair specimen, both as to reading and advertising, of what the paper will be during the coming year—except that we shall try to improve it each succeeding month. L.

THE ENGINEERING EDITION OF "MACHINERY."

The dollar edition of MACHINERY has attained the largest paid circulation ever reached by a mechanical paper and will be continued at the present price, as the Shop Edition.

There is no monthly in this country devoted to constructive mechanical engineering, although there are several valuable publications which cover the general engineering field with matter of a descriptive and popular character; and the Engineering Edition of MACHINERY has been published in response to a demand for a technical monthly for mechanical and consulting engineers, superintendents and others engaged in actual constructive work, who desire to keep closely in touch with mechanical progress without taking the time necessary to read several publications.

A number of important features will be introduced in the Engineering Edition, beginning this month, of which the following is a brief summary:

FIRST—The articles will be mainly technical, rather than descriptive or popular. They will contain specific information relating to the design, construction and operation of machinery and kindred subjects; and will thus be valuable for future as well as present reference.

SECOND—No write-ups or matter for advertising or other considerations except the merit of the article illustrated have ever been inserted in MACHINERY; but in their place a very complete summary has lately been given, containing short descriptive articles on new tools or machines that have just been placed on the market. Information concerning these is obtained systematically, and although MACHINERY already publishes more descriptions of such machines than all the other papers combined, this department will be further extended.

THIRD—It is intended that the Engineering Edition shall cover its field so thoroughly that even if no other paper is seen the reader will obtain all the important mechanical news of the month, and to this end there will be editorial note and comment on all noteworthy mechanical events in each number. This matter will be systematically gathered and will be so complete that the readers will be kept in close touch with mechanical progress. In many respects this will be the most valuable feature of the paper.

FOURTH—A digest of leading articles in the engineering papers will be given in each number, together with a list of other articles which do not receive extended mention. The digest will be edited with a view to giving the substance of items that are of the most interest to constructive engineers.

FIFTH—A data sheet will be published each month containing tables, diagrams and other information of practical value, in condensed form, most of which will be taken from the proceedings of the various engineering societies. As these proceedings are usually seen only by the members of the societies issuing them, much valuable matter is lost to professional men. The data sheets will represent this material in the most condensed possible form without sacrificing any part that is of value.

SIXTH—The collection and publication of data from the proceedings of engineering societies will be extended so as to include information covering important laboratory work conducted either by the technical colleges or private testing laboratories. The results of many important tests are now not published at all, and it is believed that their preservation in permanent form will be of great value to all who are interested therein.

The price of the Engineering Edition will be $2.00 a year, and we shall make the paper worth that to its subscribers.

* * *

The uses of aluminum are manifold and new ones are constantly discovered. It is found to have a very favorable effect upon zinc used in galvanizing. In the process of galvanizing suitable prepared sheets are drawn through a bath of melted zinc which ordinarily goes through a slow oxidation process, forms drosses, and finally loses its power to coat iron. By adding one pound of an alloy of zinc with 2 per cent of aluminum to the zinc bath, this becomes more fluid; a given weight of zinc, thus charged, coats 20 per cent more surface, the sheets are brighter and keep their color better. The amount of aluminum added is only 0.001 per cent, but it has this remarkable effect.

IMPORTANT STEAM TURBINE DEVELOPMENT.

The advent of the General Electric Co. in the steam turbine field gives renewed pertinence to the question of whether the turbine is to become a formidable rival of the steam engine, or possibly, even, to become its successor. There was great interest shown when the Westinghouse Machine Co. took up the manufacture of the Parsons steam turbine in connection with their engine business. That the General Electric Co., however, should have decided to seriously enter the steam engine field and that the type of engine they have adopted is the turbine, is even more significant. The wheel which they are preparing to manufacture is the invention of Charles G. Curtis, assignor to the Curtis Steam Turbine Co., New York City.

In 1896 experiments were made on a Curtis turbine of about 150 horse power at Stevens Institute. Its economy was about that of a simple high-speed steam engine of corresponding power, but somewhat inferior to that of a compound engine. This turbine, however, was built for experimental purposes before it had been determined what the exact requirements were, and was faulty in construction.

A Curtis turbine of 500 horse power has been in operation in the power house of the General Electric Co. at Schenectady for over a year, giving good results. Although rated at 500 horse power it has carried a load of 1,000 horse power for several hours at different times and has also established a record for continuous service by running for a period of ten days without shutting down. Oil is pumped on the bearings continuously. In common with other steam turbines the condensation is free from oil and can be used over again without injury to the boilers, while the cost for attendance is exceedingly low.

The General Electric Co. are making preparations as rapidly as possible for building turbine units in larger sizes. One of 1,500 horse power for the works of the Michigan Construction Co., Jackson, Mich., will soon be completed. This is to be direct-connected with an alternating current generator and is the first wheel which they have built to be installed outside their works. They will soon build two more 1,500 horse power turbines, for their power house at Schenectady. It is understood also that they have orders for several wheels of a larger size. One of these is for installation in the new station of the Commonwealth Electric Co., at Chicago, and there is the possibility that if the results compare favorably with those from reciprocating engines, more turbine units will follow. The design adopted for this station is novel, in that the turbine is placed horizontally, with its shaft running in a step bearing in a vertical position and the generator located directly over the wheel. The experience of the General Electric Co. in designing the step bearings for the generator shafts of the Niagara Falls Power Co. has enabled them to adopt this type of construction for the steam turbine, with a reasonable assurance of success.

Last April the steam yacht Revolution, about 140 feet long, and equipped with Curtis turbines, was launched from the yard of Chas. L. Seabury & Co., Morris Heights, N. Y. The boat has twin screws with a turbine on each shaft, and the engines have developed 2,500 horse power. While no figures have been given of the performance of the engines and the speed attained by the boat, it is known, by comparison with other vessels, that she has traveled in the vicinity of 20 knots an hour.

The first Curtis patents were issued about 1896, and it is evident from the successful progress made in the application of this wheel that it is to assume a prominent place among high-speed steam motors. Next month we shall outline briefly the characteristics of the Curtis, De Laval and Parsons turbines.

THE DAVIS ARMOR PLATE.

Lieutenant Cleland Davis, of the Navy, has discovered a process for making armor plate that promises to be vastly superior to the Krupp plate, which up to the present time has been the most effective. The method employed by the great German gunmaker consists in using a highly carbonated gas directed by many gas jets upon the face to be hardened. At a red heat the plate absorbs the excess carbon from the gas and at the end of two or three weeks of the hardening process its face becomes sufficiently carbonized to produce an extremely hard composition. Lieutenant Davis in his experiments discovered that a current of electricity directed on the armor plate by large carbon anodes would carry with it a portion of the carbon of the anode and transfer it to the body of the metal. The spot so treated became intensely hard and the depth of hardening was found to be dependent upon the time that the current was applied. Usually only a few hours were necessary to produce results equal to the Krupp process.

The contest between armor and artillery becomes wearisome at times, but the recent improvements in regard to both are of perhaps greater interest than usual. Last December it was demonstrated at the Sandy Hook proving ground that it was possible to penetrate the heaviest Krupp armor with a 12-inch shell and completely wreck the armor. This is done by employing a powerful explosive agent in the shell, which, however, is desensitized, so that it will not explode in the gun. The explosive is fired when the shell has entered the plate by means of a delay-action fuse which can be arranged to act at any given time within very narrow limits. This achievement is responsible for the refusal of the government to experiment further with guns of the Gathmann or Zalinski types. The first of these fired a high explosive by means of powder, and the second by means of compressed air, and in both cases the charge exploded against the face of the armor without penetrating it.

The armor-piercing shell now used by the government is considered one of the most important improvements in modern artillery. If the Davis armor proves to be as great an advance in armament we shall be well equipped to battle with the foes of the future. The fortunate part of it all is, however, that the improvements in artillery and armor may more frequently than not be applied in industrial work, where they are of greater utility to mankind in general than when applied simply to implements of war.

* * *

NOTES AND COMMENT.

REVIEW OF CURRENT EVENTS, TECHNICAL AND MECHANICAL.

Work has been begun upon the buildings for the new National Bureau of Standards, Washington, D. C., and if present plans are carried out the completed buildings will represent an outlay of over $1,000,000. The first building to be erected will be the mechanical laboratory, which will be followed by a main building to include the office of the director of the bureau.

What is said to be the largest steel tank in the world has been completed at Boston for the Atlantic Refining Co. It stands 36 feet high, its diameter is 90 feet, and its capacity 36,000 barrels. In the construction of the sides 144 plates of iron were used, and in the bottom 102 plates. The weight of each plate is 900 pounds. Lighter plates were used on the roof, and it required 202 of them. In the joining of the plates two tons of steel rivets were utilized.

Dr. Auer Von Welsbach, of incandescent mantle fame, is following Edison's lead in the invention of an improved storage battery. He claims much greater capacity and endurance for his battery than can be secured with the commercial lead battery now so extensively used. Important elements in the battery are certain of the rare earths, with the characteristics of which he became very familiar when developing the Welsbach mantle.

Last month we referred editorially to the Blickensderfer electrical typewriter, in which a slight depression of the keys causes the typewheel to be operated electrically and so print with uniform stroke at whatever speed the operator may manipulate the keys. An exhibition was recently given in the office of the Baltimore *Sun* of another electrical typewriter invented by J. H. W. Marriott, of Baltimore. Mr. Marriott has been personally identified with the typewriter business for many years, being formerly with the Remingtons. A feature of the new machine is its manifolding qualities, as the electrical blow can be so regulated as to strike with a force as great as 10 pounds or even more.

The largest steel freight cars yet designed are to be built by the Pressed Steel Car Co. for the Monongahela Connecting Railroad, a line having thirty miles of track, twenty locomotives and nearly three hundred cars, all owned by the Jones & Laughlins Steel Co. It connects with the Pittsburg & Lake Erie, with the Baltimore & Ohio and the Pennsylvania Railroad and crosses the Monongahela River between the Soho and Southside plants. It is used entirely for switching freight and supplies for the steel mills and other industries on its route. The cars in question will have a capacity of 200,000 pounds, just double that of the largest steel cars now in common use. These cars will be so heavy that the bridge across the Monongahela River will have to be entirely rebuilt. The cars cannot go off the home line as they are too wide and heavy to cross bridges on other railroads.

It is a dull month when we are unable to publish an item about "A Solder for Aluminium," yet the field is still open for such a solder, adapted for ordinary use by ordinary mechanics. This month our item comes from a press dispatch from Worcester, Mass., to the effect that W. H. Whitney, of Clark University, has invented a solder for aluminium that can be applied with a soldering iron, and appears to produce good results. Mr. Whitney is not ready to give any information about his invention further than to say that he has employed it with success in instrument making. The use of aluminium, "the metal of the future," has been greatly restricted by the fact that it cannot be successfully soldered or brazed by ordinary methods, and articles must either be of one piece or else riveted, pressed or otherwise fastened together by mechanical means. It is to be hoped that Mr. Whitney's invention will fully meet his expectations.

A gigantic project which is "in the air," and yet appears to be given some credence is the proposition to establish an electrical power plant at Victoria Falls, on the Zambesi River, Africa, that will equal or eclipse the Niagara plant. These falls surpass the cataract of Niagara in magnitude; but they are in the heart of the Dark Continent, and it would be necessary to transmit the power long distances to reach the important cities on the coast. The question of utilizing this power has been carefully canvassed by prominent engineers, and it is reported that a commission is to set out from London to make an investigation within a few weeks. It is improbable that the immediate future will see an actual beginning of the work, because its successful completion must depend upon railroad communications, requiring about 300 miles of track through the most difficult country for railroad building. The land is swampy and malarial, and the natives are not friendly.

A typewriter is now being manufactured at the Remington shops, Ilion, N. Y., with an attachment by which a message, mechanically correct, can be sent over a telegraph wire through the manipulation of the typewriter keys, as in typewriting. It is the invention of Charles E. Yetman, formerly a Western telegraph operator. The machine enables the operator to make the dash and dot symbols of the Morse alphabet at a high rate of speed and with little chance of an error. The typewriter has a series of rings arranged side by side on a shaft with edges serrated to correspond with the dashes and dots of the telegraphic code. The depression of a key causes its ring to rotate and make and break the circuit for the Morse letter corresponding. The machine makes no record or reproduction at the distant end of the line, and an experienced operator is required to read and receive the message; but anyone who can operate a typewriter can send a message much more accurately and at a higher rate of speed than is possible by the use of the ordinary telegraphic keys. The machine has been tried with success in various newspaper offices and in the offices of the Associated Press.

One of the applications to which the steam turbine is eminently fitted is for the operation of centrifugal pumps for fire service or any other purpose. The centrifugal pump is a fairly efficient machine when driven at the proper speeds, which are always high, and that is just what the steam turbine can do without belting up. It has decided advantages over the reciprocating pump, since there are no cylinders, pistons or valves to be cut and abraded by foreign substances in the water, so it makes no difference how dirty or gritty the water may be, it can be handled with impunity. This is a prime advantage for a fire pump, and especially for the portable fire engine, which often has to pump very bad water at high speeds. The Parsons Co., the builders of the steam turbine in England, have in operation in one English mill a centrifugal pump driven by a Parsons steam turbine at a normal speed of 2,000 turns per minute. At this speed it delivers 25,000 gallons against a head of 40 feet. In case of fire it can be speeded up to 4,000 turns per minute, when it will deliver a somewhat larger column against a head of 160 feet.

One of the interesting, not to say amazing, features of modern engineering construction is the varied and extensive uses to which concrete is being put. A grain elevator has recently been built in Buffalo having a storage capacity of 650,000 bushels, of which the foundation is of concrete up to and including the basement, ten feet high. On this foundation stand 90 steel storage bins 65 feet in depth and of various diameters up to 15 feet. Concrete is being used exclusively on the Lackawanna Railroad for retaining walls, culverts and other construction, which a few years ago would have been made of cut stone. Concrete is largely used in the construction of the new shops of the Central Railroad of New Jersey at Elizabeth, N. J., all foundations for shop walls and machine tools being made of it; also the floors. The roundhouse walls are concrete, as are the pits and wall for the turntable pit. The time-honored wooden pile has also been displaced by the concrete pile. In this case a steel tube is driven containing a steel core. The core is composed of two longitudinal sections which are removed after the tube is driven and the space is filled with concrete. This in effect makes a concrete pile with a thin outer steel shell. The inevitable disintegration of the steel shell, of course, does not affect the integrity of the pile.

THE LIGHTEST AUTOMOBILE.

Elsewhere in this number is an article upon the heavy motor trucks made by the Morgan Motor Co., Worcester, Mass., which are among the heaviest and possibly are the heaviest made in the United States. By way of contrast it is interesting to note that what will be the lightest automobile made in this country is to be manufactured at Hartford, Conn.; or, more properly, the motors for such automobiles. Part of the Acme shops, recently vacated by the Acme Machine Screw Co., have been leased for the purpose, and the motor to be built is very light in weight and is intended to be attached to ordinary bicycles. It is of French design, weighs only 20 pounds, and is capable of developing 1¼ horse power. It is known as the French Clement motor. A wheel equipped with one of them has been known to make a trip of 1,500 miles without serious breakdown; but most readers of this will probably question whether a common bicycle will be capable of long standing the strain of so powerful a propelling force, although provision is made for strengthening the front forks of wheels that are to be motor propelled. Gasoline is fed to the motor from a tank situated in front of the handle-bars, and the motor itself is clamped to the lower member of the frame in front of the rider.

ELECTRICALLY-WELDED AUTOMOBILE PARTS.

The marked increase in the number of automobiles manufactured has led the Standard Welding Co., Cleveland, O., to adapt their electric welding process to the production of several important parts for automobiles. This action, together with the influence of firms making drop forgings, is likely to be the beginning of a tendency to standardize certain parts of automobiles in the same way that bicycle parts have come to be regarded as standard. The initial effort of the Standard Welding Co. in automobile work was the manufacture of the seamless rim in various styles and diameters for wood and wire wheels. The advantages of these rims come from the high-grade material that it is possible to use and the accuracy of dimensions. This latter is especially valuable in connection with wood wheels, as it enables the maker to adopt a standard of size without special attention being given to sizing each wheel for each individual rim. As drop forgings have been used advantageously in the manufacture of automobile parts, especially axles, levers, etc., a considerable amount of special work is carried on by this company in electrically welding these special forgings to commercial iron or steel, to produce the finished product. This obviates the necessity of making long and expensive forging dies and gives great flexibility in the manufacture of articles of this class, as small articles can be readily drop-forged and welded to meet the various conditions.

ANOTHER ATTEMPT AT ELECTRICITY DIRECT FROM HEAT.

Prof. C. B. Thwing, of Syracuse (N. Y.) University, has invented a thermo-electric generator for the direct conversion of heat into electricity. The principle of the apparatus is the old one that a current may be produced in a closed circuit by heating the point of contact of two dissimilar metals. For example, if a piece of bismuth and a piece of antimony be soldered together, their free ends connected by a wire and the place where the pieces join be heated, there will be a slight current flowing across the heated point from the bismuth to the antimony. The improvement in Prof. Thwing's apparatus is that a more powerful current may be generated, and greater durability obtained than in any previous device operating on this principle. We have not been able to obtain authentic information regarding the invention, but understand that a small machine has been experimented with which has generated a 20-volt current and is applicable to light power, such as required for dental tools, etc. The metals employed are said to be alloys of iron and nickel, one of the metals being cooled with air currents at the same time that the other is heated. Prof. Thwing is at the head of the Department of Physics at Syracuse University, is in good standing among physicists, and it is not improbable that his invention may be an important step, even if a short one, toward the goal of "electricity direct from coal."

NEW METHOD OF COVERING HULLS OF VESSELS WITH COPPER.

Copper sheathing has been employed for covering the hulls of wooden sailing vessels for a great many years and is used to some extent on the hulls of steel and iron vessels, in order to reduce the quantity of barnacles and other sea growths that accumulate. When used on iron or steel hulls the latter are first sheathed with wood and then the sheet copper is applied, to prevent the electrolytic action that would occur between the copper and plating of the hull. The objection to copper sheathing is that it is almost impossible to entirely prevent electrolysis, and portions of the hull, or even valves and fittings below the water line, are almost certain to become damaged to a greater or less extent. This is especially the case if the vessel grounds or encounters an obstacle, causing part of the sheathing to be scraped off. Under such circumstances the exposed portion of the hull forms one pole of a battery, of which the copper sheathing is the other pole. At the Atlantic Iron Works, South Boston, Mass., a large steam yacht has recently been coated by an entirely new process, which, it is claimed, will produce as good results as copper sheathing and will entirely prevent electrolysis. The hull is first painted and then a coating of powdered quartz is sprayed over the painted surface. Upon this a coating of copper in powder form is then sprayed with an air brush and finally there is another coat of powdered quartz. It is claimed that the quartz serves to isolate the copper from the hull and also the particles of copper from one another; and that, if part of the coating should be rubbed off, exposing the bare hull, there would be no electrolytic action.

THE MEDAL IN HONOR OF JOHN FRITZ.

The celebration of the eightieth birthday of John Fritz, the American engineer, whose most distinguished services have been rendered in the iron and steel industry, will take place the last of next month at the Waldorf-Astoria, New York City. Last winter representative members of the four great engineering societies of America organized for the purpose of planning a suitable recognition of Mr. Fritz' career at the time of his eightieth anniversary. It was decided to establish a John Fritz medal, to be awarded every year "to the originators of the most useful scientific or industrial achievements, in perpetual honor of John Fritz and to the glory of engineering." Subscriptions were called for, and the responses have been so numerous that the success of the project is insured, several thousand dollars having been received. It is intended that the medal shall be awarded by a perpetual committee of sixteen, to be appointed or chosen in equal numbers from the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. The committee may select any person of any nationality. No award shall be made until after at least one year of consideration, and it must have the affirmative vote of at least three-fourths of the board. The belief is that this medal will be a distinction not second to the Bessemer Gold Medal, awarded by the Iron and Steel Institute of Great Britain.

"PERMANENT" MOLDS FOR CASTING IRON.

A company known as the International Foundry Co. has been incorporated in New Jersey with a large capital, to exploit a new process invented by Charles Szekely, of New York. The idea is to make "permanent" molds for iron castings, the inventor having discovered a preparation which is smeared on the insides of sand molds and which renders unnecessary breaking them up when one casting has been made. The plan is, of course, to make several castings from the same mold. This will probably make the average molder smile with contempt, but then there may be something in it. Another scheme to beat the molder has been developed by Frederick Baldt, Chester, Pa. In this process a fusible pattern is used which is embedded in sand by a suitable molding machine. The mold is then heated and the fusible pattern melted out, leaving the mold ready to receive the molten iron, or other metal. The chief novelty of this invention is the means employed to pack the sand around the pattern since the idea of a fusible pattern is a very old one and one often used by model makers and others having need for only one casting from a pattern. In such cases the pattern is commonly made from impression wax shaped to the desired form. The pattern is molded and then, if of complicated form having cores, etc., that make it impossible to pull it when made in one piece, it is melted out. Plaster of Paris is often used for the mold when the casting is to be made of a metal having a low melting temperature.

COMPOUND LOCOMOTIVES ARE TWENTY-FIVE YEARS OLD.

It is now the 25th anniversary of the application of the compound system to locomotives in France. The first compound locomotives were designed by A. Mallet and operated on the railway between Bayonne and Biarritz, France. They were built at the Creusot works and had one high-pressure and one low-pressure cylinder, with provisions for working either simple or compound. In that year the Institute of France awarded to Mallet the Fourneyron prize for mechanics, in consideration of his achievement. The use of the compound locomotive has extended throughout Europe since its introduction by Mallet and it is estimated that nearly 15,000 are now in operation on various European roads, of which two-thirds are of the Mallet type. In marked contrast to the development of the compound system abroad is the growth of compounding in this country. The first compound engine of any consequence to be tried in the United States was Dunbar's five-cylinder compound, which first ran on the Boston & Albany Road in 1883, or six years after the successful introduction of Mallet's locomotives in France. Dunbar's engine was a failure and compounding made no progress here until 1888-9. In these years Webb's three-cylinder compound was tried on the Pennsylvania R.R.; the first Baldwin-Vauclain compound was built for the Baltimore & Ohio R.R., and the first Schenectady compound having an intercepting valve to allow high-pressure steam to be used in the low-pressure cylinder was introduced.

ANOTHER GIGANTIC SUSQUEHANNA POWER PLANT.

Vast in scope is the Susquehanna power plant which is to be constructed for supplying Baltimore, Wilmington, Chester and Philadelphia with electric power. That part of the Susquehanna River where it is proposed to locate the plant is about 35 miles from Baltimore, near Peach Bottom, and almost on the boundary line between Maryland and Pennsylvania. At this point there is a fall of 120 feet within a short distance, and there are numerous islands which facilitate the location of the power house and the construction of dams. It is proposed to utilize this power for three plants, so located that each will have a fall of 40 feet and will be capable of generating 50,000 horse power. There will be about 10 per cent loss in the transmission to Baltimore. The consummation of this enterprise came last month through the consolidation of the lighting and electric railway interests of Baltimore; and the syndicate which controls these interests is also represented in the Susquehanna Electric Power Co., which will build the new power stations and supply the current. The plans as now announced contemplate one power plant of 40,000 horse power to supply the present needs of Baltimore for electric railway work and lighting; but as the demands for manufacturing and other purposes increase, the plant will be developed to as great a capacity as necessary, up to the limit of 150,000 horse power. The complete equipment for each station will include ten 5,000 horse power electrical units, for each of which there will be three pairs of 48-inch turbine wheels.

This is the fourth instance of the utilization of water power for electrical transmission on a large scale in the East, although there have been many in the Western section of the country, particularly in California. The other three Eastern plants are the Niagara Falls, the St. Lawrence plant at Massena, N. Y., and the Susquehanna plant now being constructed at Yorkhaven, Pa., near Harrisburg. It will completely eclipse its Yorkhaven rival, however, which is to have 40 units of 600 horse power each, or a total of 24,000 horse power.

WIRELESS TELEGRAPHY ON THE PACIFIC COAST.

The Fessenden system of wireless telegraphy is to be used by the government to communicate between San Francisco and the Farallone islands, which are about 30 miles from the coast. The last Congress appropriated $40,000 for a system at this point, as an aid in weather predictions, and Chief Moore of the Weather Bureau has already let part of the contract.

It is not generally known that the first practical use in this country of a wireless telegraph system was near the scene of this installation by the daily *Call* of San Francisco. In the stirring times of the Spanish war Marconi lay claim to having discovered a method of transmitting messages by electric current, without the use of wires, but for the most part was looked upon as a dreamer or a fakir. The *Call*, however, with a mingled interest in the development of science and the promotion of a good advertising scheme determined to give the apparatus a test. The instruments were procured in London and after experimenting with them more powerful apparatus was found to be necessary if messages were to be conveyed considerable distances.

More apparatus was cabled for and upon arrival was installed with a view to giving advance information from the expected transport Sherman, which was bringing a California regiment from the Philippines. With the sanction of the government the sea end of the aerial line was established on board a lightship anchored some nine miles from the entrance to the Golden Gate. The lightship dynamo supplied the electric current and her masts offered a suitable altitude for the pendant wire, while the land station was fixed at the famous Cliff House. From a mast on the top of the building on the seaward side a long wire hung with a free end down 80 feet to near the water. The Sherman was sighted on the morning of August 23, 1899, the wireless message was successfully transmitted to the shore and within thirty seconds a signal gun was fired from the dome of the *Call* building, announcing her arrival.

AIR RESISTANCE ENCOUNTERED BY MOVING TRAINS.

The results of the high-speed tests made last year on the Berlin-Zossen line have recently been made public in part. Two cars were used in these tests which were built by German manufacturers. Both had a seating capacity of fifty persons, and were of the same width and height as the standard Prussian State Railway cars. Three-phase current was transmitted from overhead conductors at a tension of 10,000 to 12,000 volts. The current was delivered to the motors at a lower voltage by static transformers on the cars. The armatures of the motors were carried on a hollow sleeve surrounding the axle which was connected to the axle by a set of springs at each end. The motors were thus connected to the axle without the interposition of reduction gearing. Each car had four motors of 250 normal horse power and 750 horse power in starting, making a total of 1,000 horse power when running and 3,000 horse power when starting.

To measure the air resistance pipes of different diameters were attached at various angles to the front of the cars and led to pressure gages from which readings were taken at different speeds. One pipe was so arranged that it could be extended to various positions in front. The readings from this pipe show that a uniform cone of compressed air about 11 feet in length was pushed ahead of the car. At a speed of 32 miles per hour the air pressure was about 2.7 pounds per square foot; at 37 miles, 4.1 pounds; at 43 miles, 5 pounds; at 50 miles, 6.2 pounds; at 62 miles, 10.4 pounds; at 75 miles, 15 pounds; at 81 miles, 17.5 pounds; at 93 miles, 23 pounds; and at 96 miles, 24.6 pounds. These results appear to show that for the speeds tested air resistance varies according to the square of the velocity as has heretofore been held, but that the coefficients of resistance have uniformly been too high. From these experiments it is deduced that air resistance per square foot of impinging surface may be found by the formula $P = .0027\ V^2$. This gives results a little over one-half that given by old air resistance table based on the coefficient .0049.

AUTOMATIC TELEPHONE EXCHANGES.

The general extension of telephone service in cities and towns to other than business places is retarded by its cost. In many cities the telephone rates seem unreasonably high and this condition is quite popularly attributed to the monopolistic privileges enjoyed by the telephone companies. While there is undoubtedly much truth in this contention, we are assured that in many places the rates are not higher than a reasonable profit on the investment demands. The one great expense of telephone service is the central exchange. The cost of installation of large exchanges and the wages of the operators are the chief sources of operation cost. The central exchange is an exception to the general rule in other lines of business that the greater the business done the less the proportionate operation cost. In the telephone business the cost of an exchange increases not in direct ratio to the number of subscribers, but rather as some power of the number. The opportunity for the cheapening of telephone service seems to be in the direction of the automatic telephone exchange. Already these remarkable machines, seemingly endowed with almost human intelligence, have been installed in some towns with very satisfactory results. The subscriber calls any number desired by rotating a disk on his instrument so as to select the number required. The machine at the central exchange automatically calls up the number, or in case the number is "busy" it warns the subscriber of that condition by a loud buzzing. Only a few attendants are required in a large exchange to see that the machinery runs without interruptions, and on Sundays and the latter part of the nights the exchanges work automatically without any attention. Complete privacy is also insured by the automatic exchange.

STEAM STEERING GEAR.

THE ADVANTAGE OF STEAM OVER HAND GEAR—TYPES OF STEAM STEERING GEAR AND METHODS OF TRANSMISSION.

ARTHUR MASTERS.

The first thing to be done upon getting a ship under way, or after releasing her from her moorings, is to guide and control her on her course, and here it is necessary in the large and swift battleships and cruisers, and vessels of the merchant marine, to provide more powerful and effective appliances than can be obtained by manual labor alone, for moving the rudder and directing the path of the ship. It is with this object that the steam steering engine is fitted.

This engine is sometimes placed in the main engine room of the vessel, as in the case of steam yachts; but more often in a special compartment of its own, near the rudder or tiller, as may be found most convenient, and as it is such a vital portion of the ship's auxiliary machinery that of the battleship or cruiser is always placed under protection of the side armor, the protective deck, or below the water line, and out of the reach of the enemy's shell. Lord Brassey's "Naval Annual" for 1892 reflects somewhat on the reliability of the steam steering gear in the following: "The man who shall invent a system of steam steering that should be as trustworthy as, say, the propelling engines of an average man-of-war, will deserve well of his country. At present no such system exists." It is now ten years since the above words were written, but in that time a wonderful improvement has taken place.

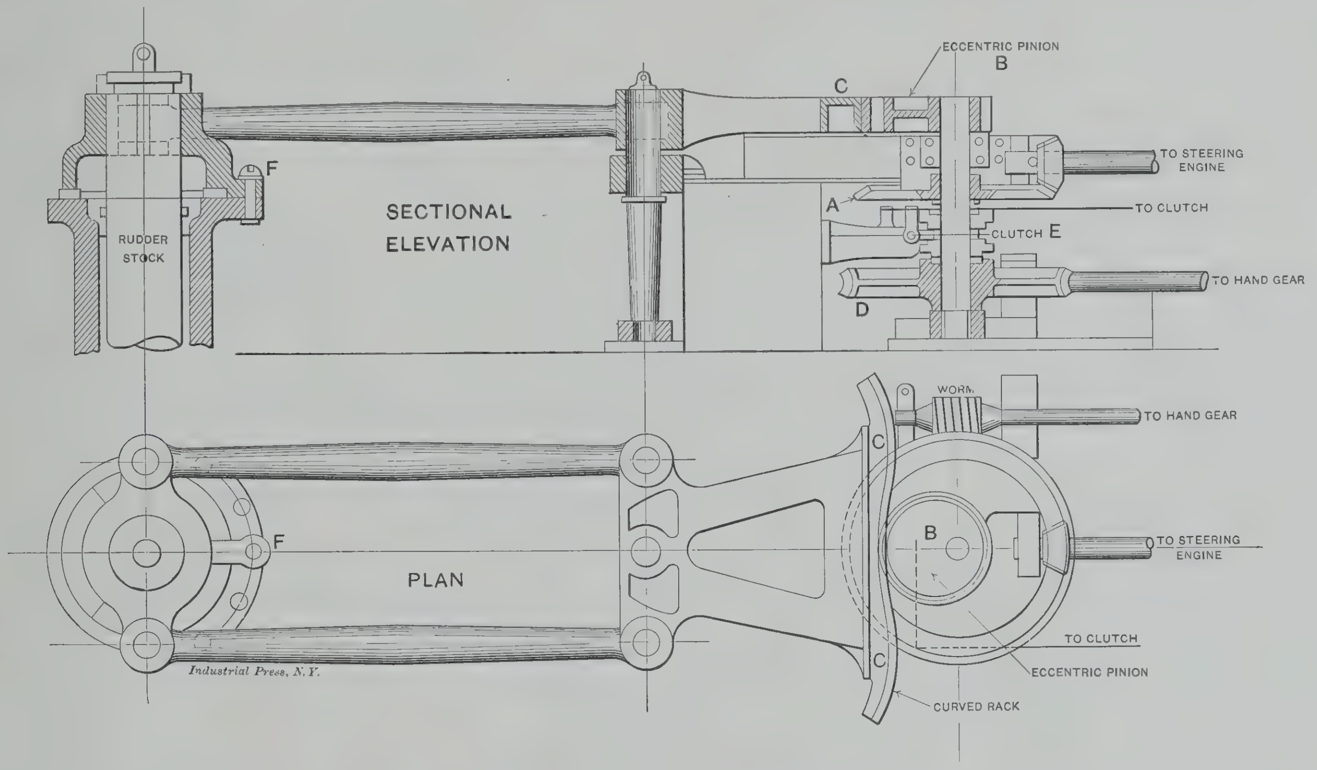


Fig. 1. Harfield's Compensating Steering Gear.

Seldom now does one hear of steam steering gear giving way, and during the recent naval war between the United States and Spain, I do not call to mind a single instance where either the steering gear or the main machinery was damaged in action.

It is usually the custom to steer the ship from the bridges, the pilot house, or the conning tower, whence a good lookout can always be kept, and where the helmsman is within easy access, and under the eye of the navigating officer. But it is possible to steer the ship by a helmsman stationed below in close proximity to the steering engine itself, to whom the necessary directions can be transmitted either by electric or mechanical telegraphs, or voice tubes. This arrangement would, of course, be adopted in the event of the mechanical connections between bridges or pilot house—which are all in more or less exposed situations—and the steering engine being disabled or shot away.

The controlling gear, which is simply the gear by which the steering engine is worked from the bridges, or any other steering station, may be composed of any one of the three following systems most commonly employed, namely, shafting and bevel wheel gearing, wire rope transmission, or hydraulic or electric telemotor. On the bridges, in the pilot house, and conning tower, is a small hand-wheel mounted on a pedestal, and to this hand-wheel the steering engine valve, known as the "controlling valve," is attached by any of the above systems reaching from the pilot house or bridge down to the main or protective deck, thence aft to where the steering engine may be situated. This is shown in Fig. 2. The motion of the hand steering wheel on the bridge, or wherever it may be worked from, is conveyed to the engine by one of the above-mentioned systems, and the controlling valve and the whole of the gear are so arranged that the rudder, which is being moved by the engine, follows the motions of the hand steering wheel exactly.

The "Great Eastern" was one of the first vessels furnished with a steering engine. This engine was designed by Mr. McFarlane Gray, and from that time up to the present large merchant steamers have been similarly fitted. Steam has been generally preferred to hydraulic power, after numerous trials, although some arrangements on the hydraulic principle have been very satisfactory. The latter gear has certain advantages, but it is heavier and more costly than steam gear; hence steam is now generally used for the purpose in warships of all classes, in torpedo boats, and merchant steamers.

The advantages of the steam steering gear are obvious, as for manœuvring purposes it is requisite to have the power of moving the rudder rapidly through large angles. In the case of hand steering, with such a multiplication of tackles between the steering wheels and tillers, it makes the loss of power in friction very considerable, and the time of putting the rudder over very long. Again it will be evident that a ship whose rudder can be put over quickly to its extreme angle will acquire angular velocity more rapidly than she would with the same rudder put over slowly. Furthermore, it has the further and important advantage of placing the control of the largest ship in the hands of one or two men—possibly in those of the commanding officer himself.

As another example of the advantage to be obtained by using steam steering engines, the British battleship "Minotaur" may be mentioned. "With manual power 78 men were required to steer her, and the helm was only got over to 23 degrees in 1½ minutes, while turning the circle occupied about 7½ minutes. With steam gear on the same vessel two men put the helm over to 35 degrees in 16 seconds, the circle was turned in about 5½ minutes, and its diameter was less than two-thirds that on the former trial."

Another instance of the superiority of steam steering over hand steering may be shown in connection with the steam trials of H. M. S. "Hermione," second-class cruiser of 4,360 tons. In moving the rudder, with steam gear (Harfield type): "From amidships to hard a-starboard, took 7 seconds; from hard a-starboard to hard a-port, 16 seconds; from hard a-port to amidships, 6 seconds, one man working the wheel. With hand gear, and with six men at the wheels, the rudder was put hard over in 55 seconds."

This gear, which is on the compensating principle, has the advantage of acting with increased power in proportion as the load increases. It is illustrated in Fig. 1. In this rigid arrangement the engine drives a horizontal bevel wheel, *A*, loose on the vertical spindle, but which, by means of a clutch keyed to the vertical shaft, rotates an eccentric pinion *B* on same shaft. This eccentric pinion gears with a rack *C*, so shaped as to always engage with the eccentric pinion while moving about a fixed center. The force is transmitted to the rudder by means of double rods, which simply transmit the force from the fixed axis to the rudder head, but do not alter it. So the fixed center may be considered to be the rudder head. Assuming the engine to exert a constant turning movement on the vertical shaft, it will be noticed that when the rudder is central the longer radius of the eccentric pinion acts on the rack, and the motion is comparatively rapid, and the force exerted is small. As the rudder increases its angle, and therefore its resistance to motion, the small radius of the eccentric pinion comes into operation and the force exerted is correspondingly increased. A worm on the hand-steering shaft and gearing with a worm wheel *D*, also loose on the vertical spindle, is provided, to enable hand power to be used, the clutch *E* being the means of transference from steam to hand power. In order to prevent any possible risk of accident when this transference occurs it may be necessary to ship the rudder pins *F* so as to secure the rudder. Sometimes a brake wheel and band is fitted for this purpose.

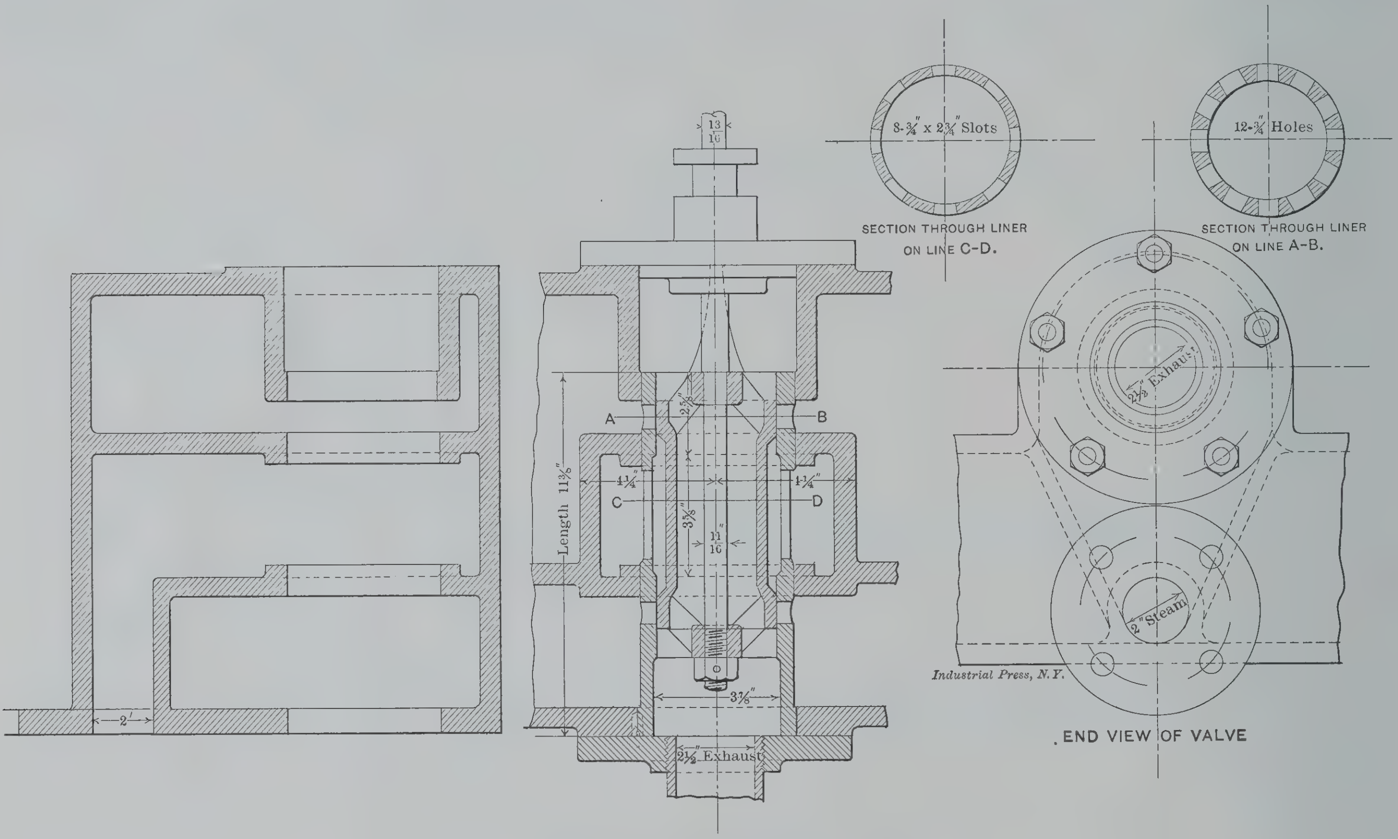


Fig. 4. Controlling Valve of Steam Steering Engine.

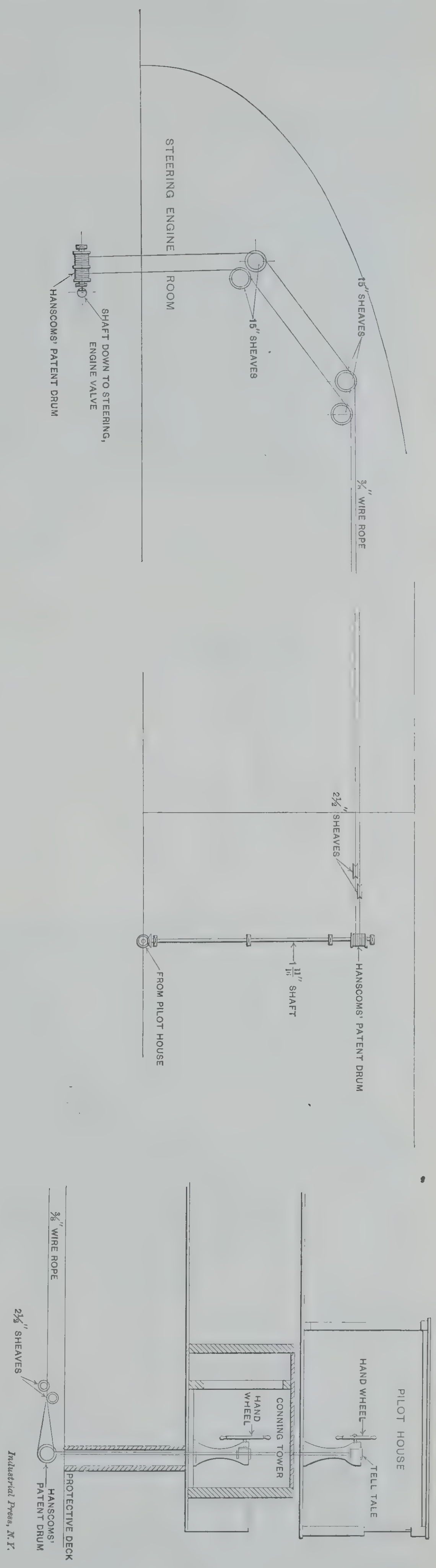
The requirements of steam steering engines for vessels in the United States Navy are that they shall be capable of putting the rudder from hard a-port to hard a-starboard, or *vice versa*, in at least 20 seconds when the vessel is moving at full speed. Fig. 3, plan view, shows the general arrangement of a steering engine as used on vessels of the United States navy, and is of the Williamson pattern. In proportioning the several parts of the engine, the strength of the rudder stock is taken as the basis of design; and into this calculation (size of rudder stock) enter the requirements of speed, maximum angle of rudder and area of rudder. It may be interesting to note here the result of experiment, namely, "One square foot drawn 10 feet per second through water, with surface normal to line of direction, gives a pressure of 112 pounds." Taking this as a basis for pressure which, in the case of a ship's rudder, varies as the square of the velocity, and is proportional to the sine of the angle, we have:

$$D = \sqrt[3]{\frac{A \times 112 \times \sin a \times V^2 \times l \times 10}{10^2 \times M}}$$

A = Area;
V = Velocity of feet per second;
l = lever in inches;
M = Moment torsion diameter of rudder head in inches.

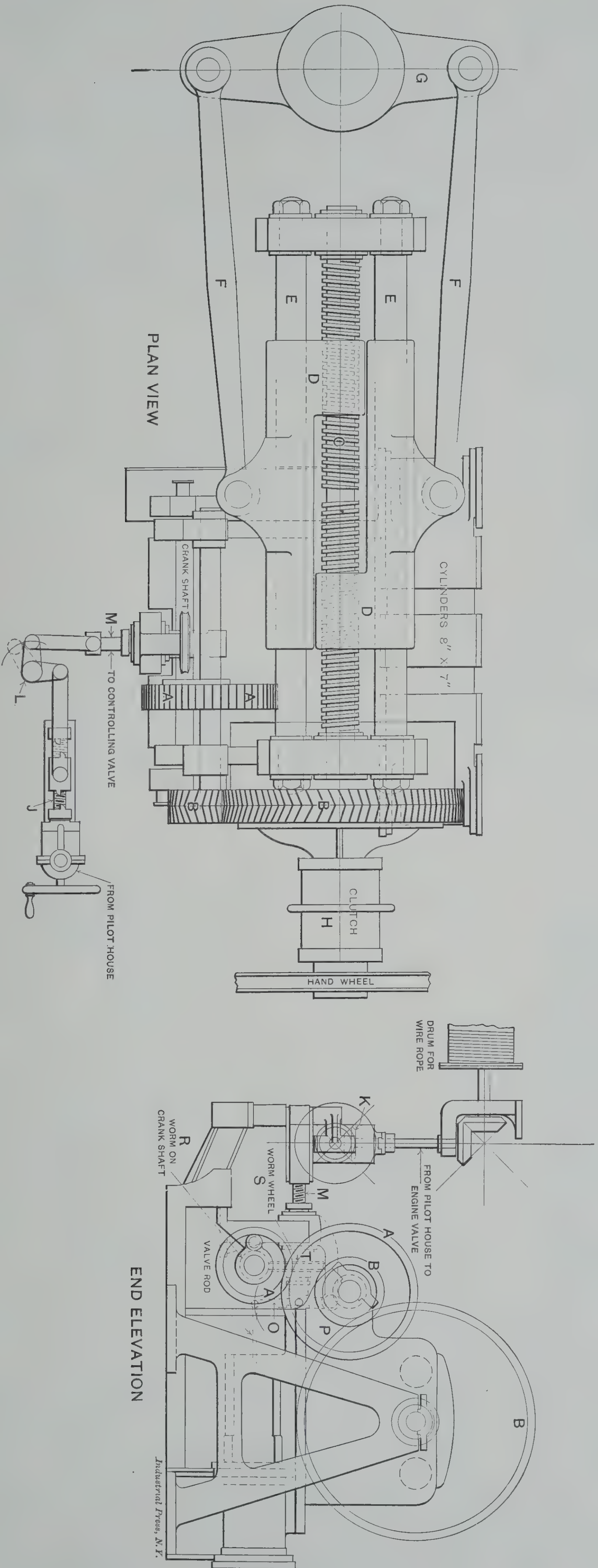
Referring again to the Williamson engine in Fig. 3, it will be noticed that the power of the engine is transmitted through double-spur gears *A*, off crank shaft, through double helical gears *B*, which operates a right-and-left handed screw *C*, on which travel right and left-handed driving nuts *D* (that is, one nut at each end of the screw), which also slide on guide rods *E*. To each driving nut is attached a side rod *F*, which is also attached to the yoke *G*, on the rudder head, and as the driving nuts approach or recede from each other, according as the rotating screw *C* revolves in one direction or the other, the necessary motion to port or starboard is communicated to the rudder. The engine is arranged so that it can be used for either steam or hand steering by changing suitable clutch *H*. The great point to be gained by this engine is to keep the wearing surfaces as large as possible so as to reduce the wear and tear. It is also essential that the steering apparatus should be simple in construction and arrangement and safe and reliable in operation; so that much skill and care are required in the details of the gear, to reduce complexity and promote efficiency.

The "controlling valve," Fig. 4, is a special feature of the steam steering engine. It not only admits steam to the engine, so that the rudder is moved to port or starboard as desired, but is so fitted that while the rudder is attaining the wished-for degree, the steering engine itself which causes the



Industrial Press, N.Y.

Fig. 2. General Arrangement of Wire Rope Transmission between Pilot House and Steering Engine.



Industrial Press, N.Y.

Fig. 3. Williamson Pattern Steering Gear used in the United States Navy.

rudder to move is also actuating and closing the controlling valve. So that as soon as the helmsman on the bridge ceases to operate the hand wheel, and the rudder has been placed to the desired degree, the controlling valve shuts off the steam, and the steering engine stops, remaining so until the rudder is to be moved again, when the controlling gear and steering engine are again brought into operation.

A more detailed description of the controlling valve gear may be interesting. As shown in Fig. 3, the automatic attachment is fitted on the engine and has stops for steam movement, so that the engine cannot run farther than the hard-over point, which prevents pulling against the rudder stops. The screw *J* is caused to revolve by the action of the bevel wheels *K*, which are operated by an upright shaft from the steering wheel in the pilot house. This screw operates on the bell-crank lever working on the fulcrum *L*, thus giving motion to shaft *M*, which terminates in lever *O*, working about its fulcrum *P*. On end of lever *O* is attached a valve rod.

On the main crankshaft a worm *R* is fixed, which, as the shaft revolves, works the wormwheel *S*, to which is attached sleeve *T*. As the valve is opened and the engine is started in either direction, the tendency of the latter is to follow up the motion given the shaft *M*, and the moment the hand steering wheel ceases to move the starting valve moves back to its central position, and thus stops the engine.

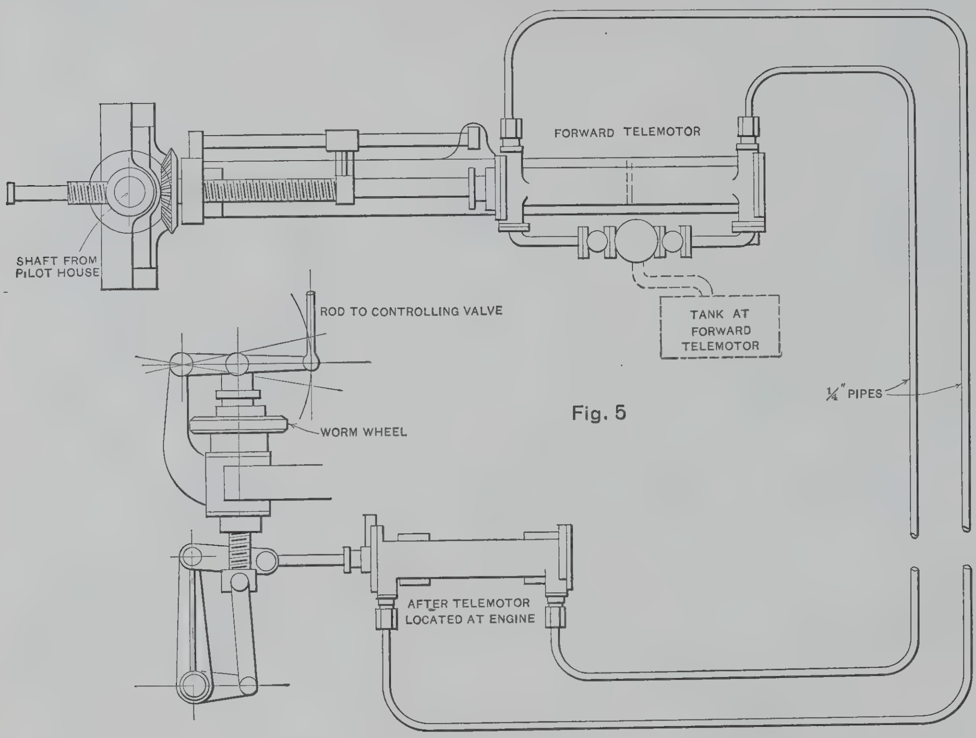
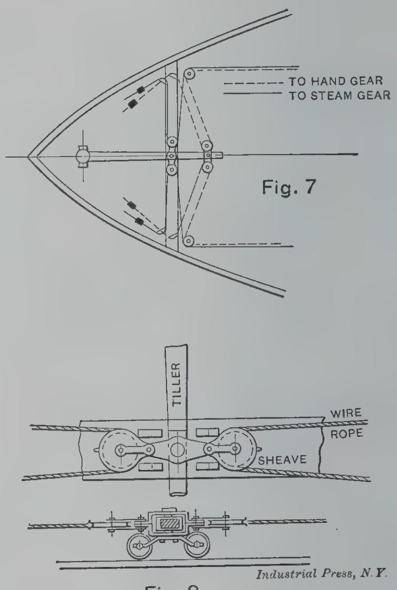


Fig. 5. Hydraulic Telemotor Type of Transmission.



Industrial Press, N.Y.

Figs. 7 and 8. Rapson's Slide for giving Uniform Turning Moment to the Rudder.

There are, therefore, two forces acting on the valve: The one from the steering wheel, worked by hand, which moves the valve and starts the engine in a direction to put the rudder to starboard or port; and the other from the engine itself, which always tends to replace the valve in its central position and stop the engine. Consequently, the engine only keeps in motion while the steering wheel is being worked, and as soon as the steersman ceases turning the wheel the steering engine stops, the rudder remaining in the position to which it has been put. There are many other arrangements for producing this result, but the essential principle in all types of steering engines is the same as above described.

The valve being actuated by the hand wheel opens the same gradually as the rudder goes over, thus increasing the power as the load becomes greater. The controlling valve also effects economy in the working, and produces the same effect as increasing the number of revolutions per degree as the rudder goes over.

Of the three systems of "controlling gear" above mentioned, the most ingenious adaptation is that of the hydraulic telemotor, Fig. 5. Instead of transmitting the motion of the steering wheel to the engine by means of shafting and bevel wheels, or wire rope, the hydraulic telemotor is sometimes used. In this the motion is transmitted by water pressure in small pipes, a certain motion of the piston of a water cylinder at the steering position on deck, producing a similar motion in the piston of a water cylinder near the steering engine, by means of which the reversing valve is moved.

Where it is desired to lead a long distance from pilot house to steering engine, as in the case of government cruisers and battleships, wire rope in connection with Hanscom's patent transmission drums, Fig. 1, is preferable to shafting with bevel gears, or universal joints. It can be more easily led over sheaves whose roller bearings reduce the friction to a minimum, while that of the shafting must necessarily be considerable, especially when the lead aft may be very irregular. Again, a great saving in weight is obtained by employing wire rope transmission.

Various methods are adopted for making the connection between the steering engine and rudder. The first instance, I think, of the employment of right and left-handed screw steering gear was in the steamship "Lancefield," built and engined by Robt. Napier & Sons, Glasgow, in 1861. Fig. 6 is a copy of the sketch taken from the actual gear. Besides those shown in Figs. 2, 3 and 6, Figs. 7 and 8 show another arrangement, known as "Rapson's slide," also designed to promote uniformity in the turning moment for all angles of the rudder, and which has been generally found very efficient. The end of the tiller is rectangular in section, perfectly true and parallel. A carriage, fitted with a brass swiveling block, runs on guides carried from side to side of the ship, square to fore and aft center line. This swiveling block fits over the rectangular end of the tiller, and is arranged to allow a certain amount of rotary motion in a horizontal plane. The carriage is worked to port or starboard by chain or wire rope from the steering gear. As the rudder is turned, the end of the tiller slides in the block, and thus increases its effective length, whereby the turning moment is uniform for all angles of the tiller.

The "work" to be done in putting a rudder over to any angle includes that required to overcome the moment of the pressure about the axis, and that needed to overcome the frictional and other resistances of pintles, bearings and steering gear proper. The "useful work" is that done in overcoming the moment of the effective pressure on the rudder at each instant as it moves from amidships to the extreme angle.

Normal pressure on rudder $= 1.12$ pounds $\times$ area $\times$ $(V)^2$
Useful work $W =$ normal pressure $\times$ ½ mean breadth $\times$ versin, a $T =$ time in seconds in putting rudder hard over.

$$\text{Net horse power} = \frac{W}{550 \times T}$$

The force required at the end of the tiller to hold the rudder at any angle will, of course, depend upon the length of the tiller, and the mode of applying the force. In Fig. 9 an ordinary rudder is shown. The resultant pressure upon it is P, acting through the center of effort C, of the immersed rudder area. $A\,T$ represents the tiller. Q equals force required at its end.

$$P \times A\,C = Q \times A\,T.$$

Neglecting friction, the force Q at the tiller end will vary with distance $A\,C$ of the center of effort from the axis of rudder. On the same assumption the force Q may be determined approximately for any helm angle, if the distance $A\,C$ is known, since the normal pressure P can be roughly estimated.

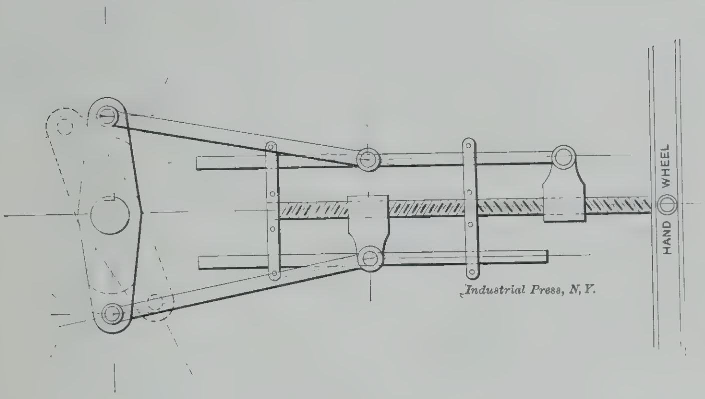


Fig. 6. Screw Steering Gear, S. S. Lancefield.

M. Joessel, of the French navy, was led from his experiments to a very simple law that confirms previous practice, which is, that "for a rectangular plate hinged at its fore edge, and inclined at an angle a to the line of motion, the moment of the normal pressure about the axis divided by sin a is a constant." Using the notation of Fig. 9, this law is as follows:

$$P \times A\,C = \text{constant} \times \sin a$$

The constant in this expression is simply the moment of the normal pressure when the rudder advances at right angles to itself, which moment can be found by rules already given. If this law be accepted, an estimate for the force required at the tiller end at an angle a can be readily made. Again, according to M. Joessel the center of pressure of a rectangular plate is at a distance from its forward edge. $d = .195\,b + .305 \sin a$; at an angle of 35 degrees this becomes $d = .37\,b$. As the center of gravity of a rectangle is at a distance of ½ b from the forward edge this distance would be .74 of the distance of the center of gravity from the forward edge. According to other authorities the pressure at any angle is approximately proportional to the direct pressure multiplied by the sine of the angle. This would make the moment on the rudder head at an angle a:

$M = 1.12 \times 12 \times A \times V^2 \times \sin a \times \frac{1}{2}\,b\,(.39 + .61 \sin a)$; or since $A \times \frac{1}{2}\,b = m =$ the geometrical moment of the rudder about its axis: $m = 13.44\,(.39 + .61 \sin a) \sin a\; m\,V^2$. Where

$M =$ the moment in pound inches.

$a =$ the angle of rudder to keel.

$m =$ the geometrical moment of the rudder about its axis in feet cubed.

$V =$ velocity of water in feet per second.

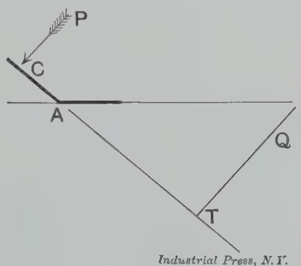


Fig. 9.

For an angle of 35 degrees this would be:

$$M = 13.44 \times .74 \sin a\; m\,V^2.$$

On the other hand, as above stated, the moment M is approximately equal to the moment of the direct pressure multiplied by the sine of angle a, hence $M = 13.44, \sin a\;\; m\;\; V^2$. The preceding value is therefore only about ¾ of that just given.

In the analysis of the trial of the U. S. S. "Minneapolis" steering gear the latter formula was used in determining the moments on the rudder head for every five degrees from 0 to 35.

Area of rudder = 166 square feet.

Moment = 975 feet cubed.

Hence $C\,G = 5.87$ feet from axis.

The following are the results in pound inches: 0 degree = 0000000; 5 degrees = 1841300; 10 degrees = 3668500; 15 degrees = 5467900; 20 degrees = 7225500; 25 degrees = 8928300; 30 degrees = 10563000; 35 degrees = 12118000.

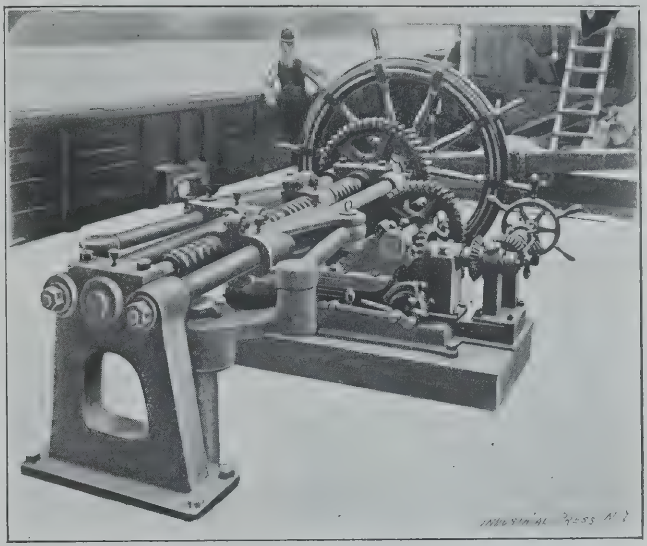


Fig. 10 Steering Gear of Steam Yacht "Aztec," Rear View.

Let us now consider the transmission of this moment to the screw shaft, "Minneapolis," receiving the power of the steering engine. The engine in this ship is similar to the one of the Williamson type, described above. Speed 23.77 knots. or $V = 40.15$ feet per second. The steering engine of this vessel has two cylinders, 13 inches × 10 inches, geared from the engine to the screw shaft with gears of ratio of 17 to 70. The reducing valve on this trial was set at 75 pounds per gage per square inch in the steam pipe. Adding 7 pounds for the vacuum in the exhaust pipe we have a total of 82 pounds. To this apply the coefficient K of the maximum turning moment for a cylinder of .35 or .70 for the two cylinders, then we have: Area of each piston $A = 132.73$; radius = 5 inches; steam pressure 82 pounds. The moment on screw shaft is:

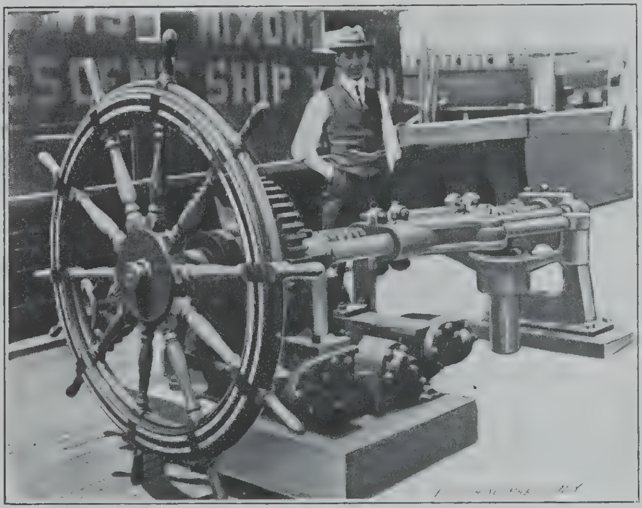


Fig. 11. Steering Gear of Steam Yacht "Aztec," Front View.

$M_2 = 132.73 \times 5 \times 82 \times .70 \times {}^{70}/_{17} = 156860$ pound inches.

That is to say, the maximum turning moment which the engine could put on the screw shaft while running at a fair speed is about 156860 pound inches.

In the steam trials of the U. S. S. "Brooklyn" the following conditions of the steering gear were noted: Area of rudder, 184 square feet; moment 1194.4 feet cubed; hence $CG = 6.5$ feet from axis. Speed 20 knots, maximum rudder angle 35 degrees. The screw shaft was geared to the engine shaft by gears 17 to 70; therefore $M = 13.44 \times 1198.4 \times \sin 35$ degrees $\times V^2$. Now the speed of the "Minneapolis" was about 20 knots, and that of the screw race 23.77 knots, equivalent to about 16 per cent. slip. The contract speed of the "Brooklyn" was 20 knots. We will take the same slip and speed V as on the "Minneapolis," where $V = 40.15$ feet per second. We thus obtain:

M_2 at 35 degrees $= 169360$ pound inches, without friction. If we allow an efficiency of the screw gear of 50 per cent. the moment which will be required to be produced on the screw shaft by the engine will be 338720 pound inches. This geared to the engine crank in the ratio of 70 to 17 gives a moment on the engine shaft of 82262 pound inches. Allowing 100 pounds steam per gage, 7 pounds vacuum and coefficient K of 70, we have: Since $KRAP =$ moment, $RA = 1098.6$ inches cubed, hence the cylinder volume should be about 2196.6 cubic inches.

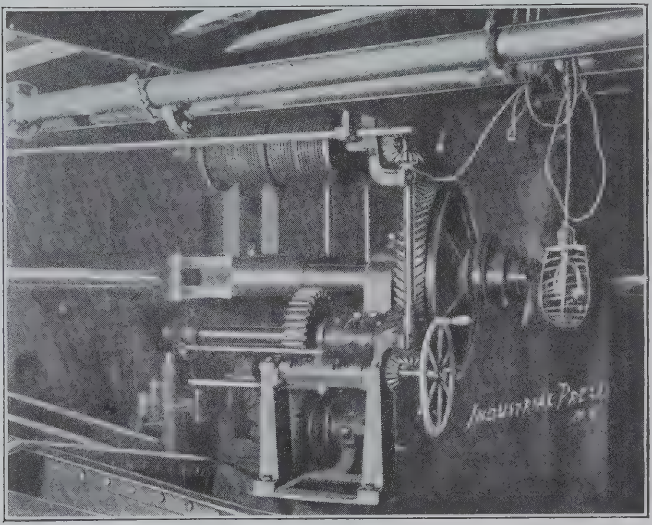


Fig. 12. Steam Steering Engine, U. S. S. "Florida."

I have considered here somewhat at length the steam steering gear, and while incidental mention has been made of the hydraulic steering gear, yet another and very successful form of steering gear has been found in the substitution of electric motors for the steam engine. That this form of steering gear is a success is demonstrated by the fact that after being carefully investigated and tested, it has been fitted and specified for several vessels of foreign governments, notably in the cases of the Russian cruiser "Variag," and the Russian battleship "Retvizan." The remarkable results obtained on trial of the former vessel, July 26th, 1900, may well be remembered, and the most successful operation of her steering gear during the voyage from the Delaware breakwater to Vladivostok resulted in the electric steering gear being added to the specifications of one or two large vessels now building for the U. S. merchant marine.

* * *

A number of portable machines of an interesting type are in use at the Fore River shipyard. They are for countersinking the rivet holes in ship plates. The practice commonly followed in shipyards is to have swing drills attached to the walls or supporting columns of the plate shed, which are in effect simple radial drills of great length of arm. The machines alluded to are mounted on two wheels and are provided with a long handle for the operator. An electric motor is mounted on the truck to drive the vertical spindle carrying the countersinking tool. The spindle is located between the end of the lever and the wheels near the latter so that the operator has in effect a long lever feed handle by which he controls the machine. The lever is also used to move the machine around from one hole to another in the plate as it lies flat on the floor. Altogether the application of electricity making a portable tool for this work makes a very neat and apparently effective tool for this class of work.

THE MACHINE TOOL METROPOLIS.

THE MACHINE TOOL SHOPS OF CINCINNATI—THEIR CONCENTRATION IN THE MILL CREEK DISTRICT.

Ten years ago Cincinnati was one of a half dozen cities in this country well known in connection with the manufacture of machine tools. Five years later it was one of three or four. To-day it leads the world; and a noteworthy feature of this remarkable development is that with few exceptions it has been confined to a strip of territory known as Mill Creek Valley, running north and south, and so narrow as to be readily shown in a single column of MACHINERY. Since 1894, when the movement to this machine tool section was begun by the Cincinnati Milling Machine Co., a score of manufacturers have built or are building plants in that territory—many of them new concerns that have leaped into prosperity during the last few years, and others who found the old quarters too small for their increasing business.

We have been unable to show on the map the location of several of the largest Cincinnati tool manufacturers—notably the Bickford Drill and Tool Co., the American Tool Works Co., R. K. LeBlond Machine Tool Co., and the Sebastian Lathe Co., as these works are some distance from the section covered by the map; nor have we made any effort to include other large manufacturers who are not makers of machine tools, such as the Fay & Egan Co., the Bullock Electric Co., Laidlaw, Dunn, Gordon Co., Lane & Bodley Co., the object of the article being primarily to show the new machine tool section of the city.

1—The Fosdick Machine Tool Co. was started in 1887 near the plant of the American Tool Works, and moved into their present plant in 1898. Their product is radial drills exclusively, and they employ about 100 men. Philip Fosdick is president, Thomas H. Richardson vice-president, and William Herman general manager.

2—The Roach & Von Wyck Machine Tool Co. began in February, 1902, to manufacture lathes, and are just starting up in their new building on Elmore St. and C. H. & D. R. R.

3—The Lodge & Shipley Machine Tool Co. was established in March, 1892, as the Ohio Machine Tool Works, Wm. Lodge, proprietor, and was incorporated in August of the same year as the Lodge & Shipley Machine Tool Co. Their present plant on Colerain Ave. was established in January, 1899, and gives employment to from 400 to 450 men, building lathes and their attachments exclusively.

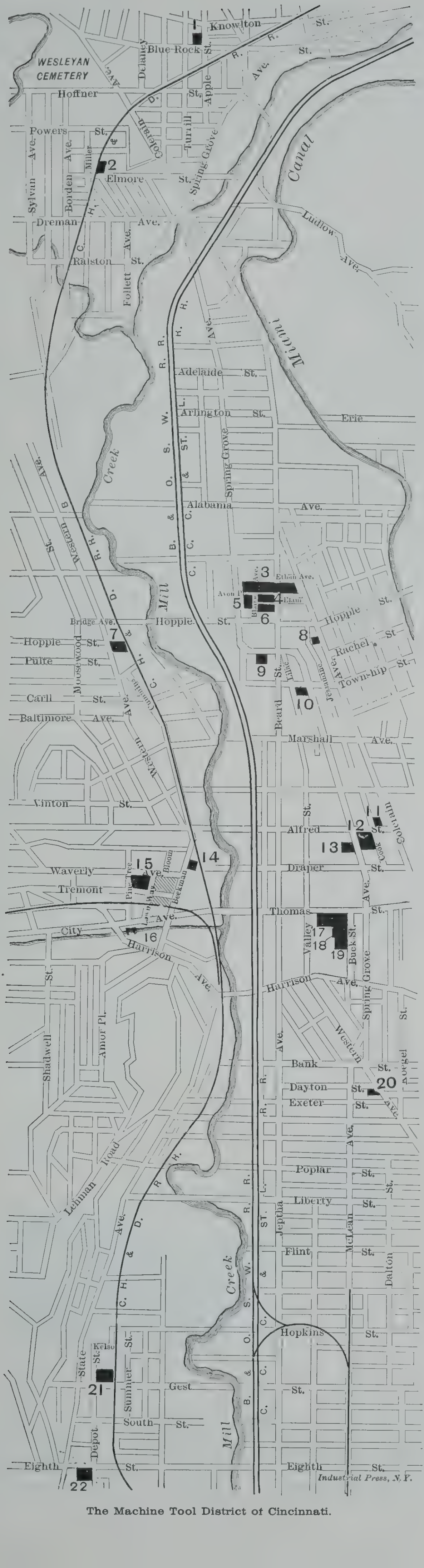
4—The Dietz Machine Tool Co. started in their new plant on Beard St., near Elam, in 1901 building engine lathes.

5—The Oesterlein Machine Co. was started by William Oesterlein in 1886 to manufacture friction clutches. In 1897 the manufacture of milling machines was added, and in 1899 they moved to their present plant at Beard and Elam Sts., where they occupy about 11,000 feet of floor space, manufacturing plain and universal milling machines, cutter and tool grinders, and friction clutch pulleys.

6—The Cincinnati Shaper Co. was established in 1898. They build pillar and traverse shapers exclusively, employing about 90 mechanics. They are at present located on Sycamore St., but are building a new shop at Colerain Ave. and Elam St., which they expect to have ready to occupy about the middle of October. Their new works will be 90 feet wide by 290 feet long, with a boiler and engine house 40 by 75 feet.

7—The Belmer Machine Tool Co. built their present shop on Western Avenue near Hopple Street in 1900 and produce planers exclusively.

8—John Steptoe & Co. was established in 1845, and on his death in 1888 the business was purchased by Mr. G. W. Otting and Mr. Adam Lauther, who ceased the manufacture of the general line of machine tools formerly made by Mr. Steptoe and devoted their entire attention to shapers. They now produce these machines of both the crank and geared type, making from 14-inch to 32-inch stroke. They employ 75 hands. For many years they have been located at 75 to 79 Elm St., but are now building a new plant on Colerain Ave., which they expect to occupy about October 1. The building will front on that avenue and extend to Jessamine St. in the rear. The main building will be 65 by 140 feet, two stories high, with two wings 50 by 100 feet each, one story high.



The Machine Tool District of Cincinnati.

9—The Rahn-Mayer-Carpenter Co. was established in 1895 and located in their present plant on Spring Grove Ave. in 1899. They build lathes exclusively from 16-inch to 32-inch swing, engine, turret, gap and pan lathes, employing about one hundred men.

10—Smith & Mills located at their present plant, corner Spring Grove and Township Streets, in 1896, and make a specialty of crank and geared shapers.

11—Greaves, Klusman & Co. was established in 1889 for the manufacture of woodworking machinery on West Second St. The personnel of the firm changed in 1898, W. A. Greaves, H. H. Klusman and Henry Korb succeeding the old firm of Greaves & Klusman; and in that year they began the manufacture of engine lathes, 17, 19, 22 and 24-inch swing. The firm moved to their present shops, Cook and Alfred Sts., in 1899, and employ 100 hands on engine lathes and on a large line of woodworking machinery.

12—The Cincinnati Milling Machine Co. had its origin in a partnership formed by Mr. Fred Holz and Mr. George A. Mueller in 1874. The business at that time was machine jobbing. Later the manufacture of screws, taps and dies was taken up and the company incorporated under the title of the Cincinnati Screw and Tap Co. Quite early in the existence of this company the need of a milling machine became apparent, and for lack of money a machine was built in their own shop, and from time to time others were built for some of their friends. In 1887 Mr. Fred A. Geier became associated with the firm, taking the office of secretary and treasurer. In 1889 the screw, tap and die business was sold out, and the manufacture of milling machines was taken up as a specialty. In 1891 they removed to their present location, Spring Grove Ave., Alfred and Cook Sts., erecting a two-story shop 50 by 120 feet, and inaugurating the movement to what is now the machine tool section of Cincinnati. Since that year a number of additions have been made to their land and buildings, and they occupy at present a plot of ground 170 by 240 feet, having a frontage on three streets, and practically all covered with buildings. Since 1889 the company has confined itself exclusively to the manufacture of upright knee and pillar type milling machines with power feeds, restricting its product to a limited number of sizes of these machines, which range in weight from 1,525 pounds to 5,000 pounds. The manufacture of a universal cutter and tool grinder was taken up in 1888, in which year the company received its first order from the European field, the trade from which subsequently grew to very large proportions. During its history the Cincinnati Milling Machine Co. has turned out about 4,000 milling machines and 2,000 cutter and tool grinders.

13—William Powell & Co., 2525 to 2531 Spring Grove Avenue, manufacturers of brass goods and specialties, were formerly located in the old manufacturing section and were one of the first to move into the district shown on the map. Their location in this section preceded by several years the movement of the machine tool builders.

14—The Knecht Bros. Co. occupy part of the Cincinnati Screw and Tap Co.'s building on Beekman Street for the manufacture of light drills.

15—The Lunkenheimer Co., while not manufacturers of machine tools, are building one of the largest plants in the Mill Creek section and on that account are entitled to mention in this article. This firm was established in 1862 and incorporated in 1889. They manufacture valves of every description, injectors, whistles, water gages, steam cocks, lubricators, oil pumps and oiling devices, employing over six hundred skilled mechanics, and are probably the largest manufacturers in their line in the world. The ruled sections show portions of their works in process of erection.

16—The William E. Gang Co. started in business in a small way in April, 1893. The following month the panic set in, but the young firm successfully struggled through it, and at the end of five years made arrangements to build a new plant on Queen City Ave., where they are at present located. They produce radial drills exclusively.

17—Schumacher & Boye occupy a large plant on the corner of Queen City Avenue and Buck Street devoted to the manufacture of lathes exclusively, from 18-inch to 42-inch swing.

18—The Dreses Machine Tool Co. was established in 1896 on Buck St. near Queen City Ave. They make a specialty of radials, screw and turret machinery, and average about 110 employees.

19—The Cincinnati Planer Co. started in business in 1899, erecting the plant they now occupy. The original buildings covered a floor space of 10,000 square feet, but have since been added to so that they now have a floor area of 26,000 square feet. This company employs about 100 men, and builds metal planers exclusively, from 24 inches to 72 inches.

20—The Cincinnati Machine Tool Co. was established in 1899 at the corner of Western Ave. and Dayton St. They make a specialty of upright drills and build a complete line, ranging from 21 inches to 42 inches, inclusive. This firm employs between 50 and 60 men.

21—The G. A. Gray Co., the largest manufacturers of planers in the country, were for many years located on Sycamore Street and moved in 1898 to their present plant, Gest Street and C. H. & D. R.R., which comprises three buildings aggregating some thirty thousand feet of floor space.

22—The Bradford Machine Tool Co. was established in 1840 by James Bradford under the firm name of James Bradford & Co. for the manufacture of mill machinery. In 1876, shortly after Mr. Bradford's death, it was incorporated as the Bradford Mill Co. with Jacob R. Stewart as president, who had been with the company since 1866. They began the manufacture of machine tools in 1889, and this branch of their business grew until it was found expedient to discontinue the manufacture of mill machinery, so as to make room for the increased demand for the company's machine tool product. They have been in their present location, Eighth and Evans Sts. since 1881, and their entire works for a number of years have been devoted exclusively to the manufacture of engine lathes, for which they employ about 60,000 square feet of floor space and 200 men. The company's name was changed in 1900 from the Bradford Mill Co. to the Bradford Machine Tool Co., and the officers are George F. Stewart, president, and W. T. S. Johnson, superintendent.

The following plants are located in parts of the city not shown on the map:

William Barker & Co. were established in 1880 and moved to their present plant, corner of Culvert and Pioneer Streets, in 1899. They manufacture lathes and shapers and employ about thirty hands.

The A. Streit Machine Co. was established in 1892 and located in their present plant in 1894. They manufacture boring machines, turning lathes and pulley tapping machines, and employ about twenty-five men.

The Wais-King Tool Co., 39 East Third St., was incorporated in 1901 and employs about 30 men, producing seven sizes of punches and shears and four sizes of vertical boring and turning mills.

The R. K. LeBlond Machine Tool Co. were established in 1887 and moved in 1888 to their present plant, 4621 Eastern Ave., which is at the other end of the city from the Mill Creek section. They employ 200 machinists and manufacture lathes and milling machines.

The Mueller Machine Tool Co. started last April building radial drills, having a well-equipped shop at 216 West Pearl St., occupying about 5,000 square feet of floor space and employing 30 hands. Mr. Mueller of this firm was formerly of the firm of Dreses, Mueller & Co.

The Sebastian Lathe Co. started in 1884 and have been building engine lathes continuously since that year, which makes them one of the oldest manufacturers in that line in Cincinnati. They confine their product to the smaller sizes of engine lathes and to foot lathes, and are employing about 45 men.

The Bickford Drill and Tool Co. was established in 1874 and employs 175 men, building radial and multiple drills exclusively. They have been in business in the present location, corner of Front and Pike Sts., ever since the company was started; but their plant has been entirely rebuilt during recent years. The officers of this firm are H. C. Hoefinghoff, president and general manager; Lewis G. Keck, secretary and treasurer, and H. M. Norris, works manager.

McCrosky & Huber, located at 208 Lawrence St., started in business about two years ago with very little capital, but through hard work have built up a prosperous business employing about twelve men in the manufacture of universal adjustable reamers. Both members of the firm are practical machinists.

The Hisey-Wolf Machine Co. are located at 77-79 Elm St. in the old manufacturing section of the city. This is practically a new concern, which started in business January 1, 1902, and manufactures portable electrically-driven center grinders, electrical bench grinders and electrically-driven sensitive drill presses. Their business has been remarkably successful in the short time they have been running.

The American Tool Works Co. operate a large plant at Sixth St., Eggleston Ave. and Culvert St. in the older manufacturing section. The original plant was established twenty years ago and was among the pioneers in machine tool manufacture in Cincinnati. The increased demand for their tools has necessitated a steady expansion of factory facilities until the plant as it now stands comprises a total of about 100,000 square feet of available floor space and gives regular employment to between six and seven hundred men. The American Tool Works Co. build engine lathes, planers, upright drills, radial drills, shapers and boring mills. Under the present system of shop management the works are divided into distinct departments—Department A, entirely devoted to the construction of small lathes; Department B, to large lathes; Department C, entirely to planers, and so on throughout the different work.

A detailed estimate by competent authorities places the total annual value of the product turned out by the thirty machine tool manufacturers mentioned above, at $5,046,000.

* * *

The Cramp shipyard in Philadelphia, says a history of the enterprise just issued by the William Cramp & Sons Ship and Engine Building Co., was founded in 1830 by William Cramp, who remained at the head of the company for 49 years. From a very small affair the main shipyard now covers 46 acres, with docks covering about 6½ acres, or 52.4 acres in all. The principal building is 1,200 feet long, 72 feet wide, with a ground and floor space of 460,000 square feet. It employs a maximum of 8,000 men. Counting vessels under construction, the Cramp shipyard has built 321 vessels and 220 engines. Of these vessels 25 have been United States steam warships, constructed at various dates since 1861, and including the New Ironsides, of the Civil War, and the new battleships Iowa, Alabama, Maine, Colorado and Pennsylvania, the three last not yet completed. One Japanese and six Russian warships have also been built at the same yards. —*Engineering News.*

* * *

HYDRAULIC TESTING MACHINE.

The accompanying half-tone illustrations are from photographs of a large, horizontal hydraulic testing machine, recently built by the Riehle Bros. Testing Machine Co., Philadelphia, Pa., for John A. Roebling's Sons Co., Trenton, N. J. As the machine was ordered primarily for testing the cables used in the construction of the new Brooklyn Bridge, now in process of erection, it has a timely interest apart from its mechanical features.

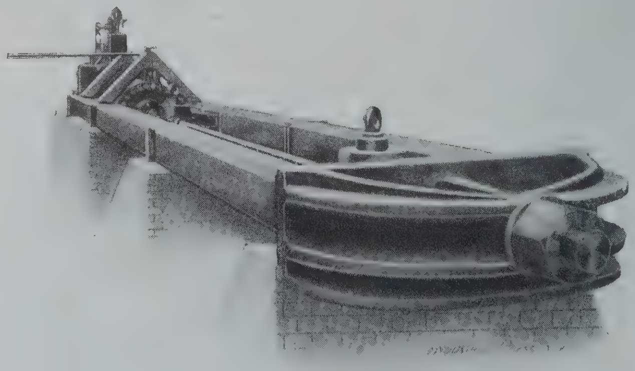


Fig. 1. Testing Machine from Anchor End.

The machine has a capacity for testing specimens in tension 18 feet long between the center of pins or shackles. The tensile stress is produced by means of a large hydraulic cylinder, in which the plunger has a travel of four feet to take up the slack and stretch in the cable. In Fig. 3 are shown details of the testing machine. The hydraulic cylinder, *E*, is suspended from the arched girders, *H H*, by links, and is free to swing slightly in an endwise direction. The cable is held by the pins *P P* and when pressure is applied in the cylinder the plunger moves to the left and the cylinder tends to move to the right, but is checked in its movement by the yokes, which hook over the knife edges 2 2, of the weighing apparatus at the left end of the machine. There are five levers in the weighing apparatus, marked *A*, *A*, *B*, *C* and *D*. Those at *A*, *A* are just alike and have fulcrums at 3, 3, while the stress due to the load on the machine is applied at points 2, 2, as mentioned above. The scale beam is at *D* and the connections between this and the primary levers, *A A* are clearly indicated. Two springs, *S S*, serve to retain the cylinder in its normal position to absorb any shock upon breaking a specimen.

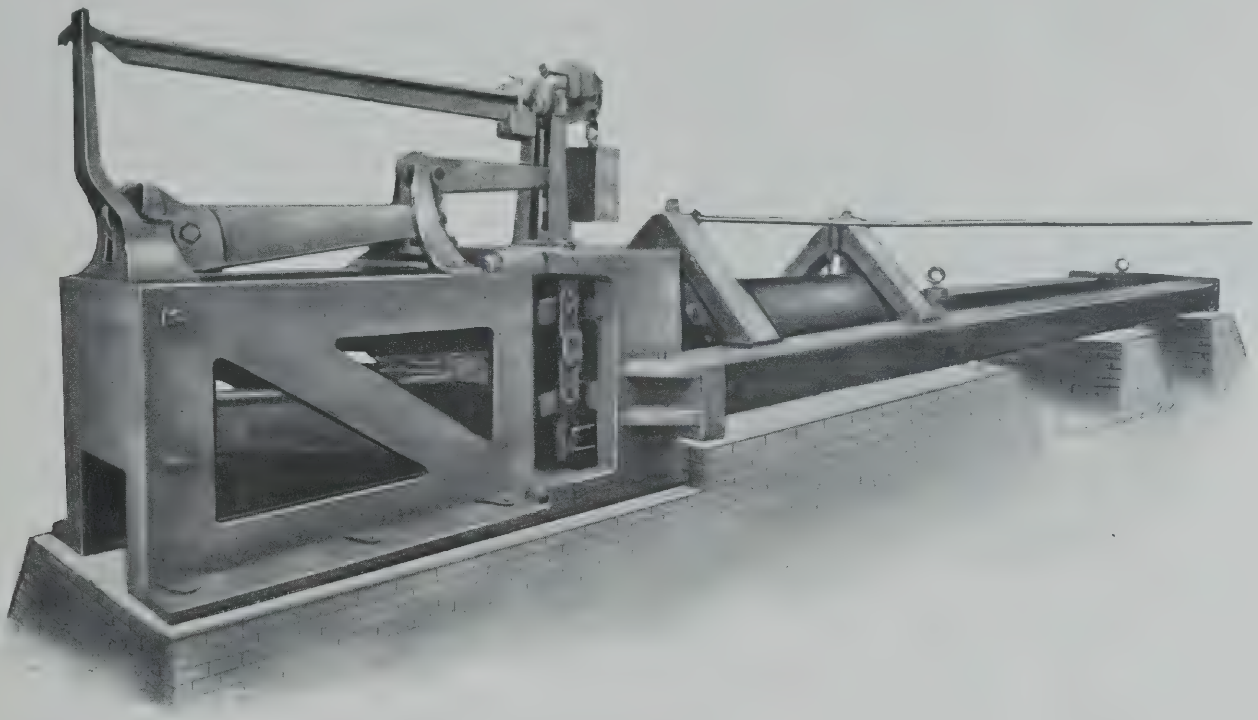


Fig. 2. General View of Machine for Testing Strands of Brooklyn Bridge Cables.

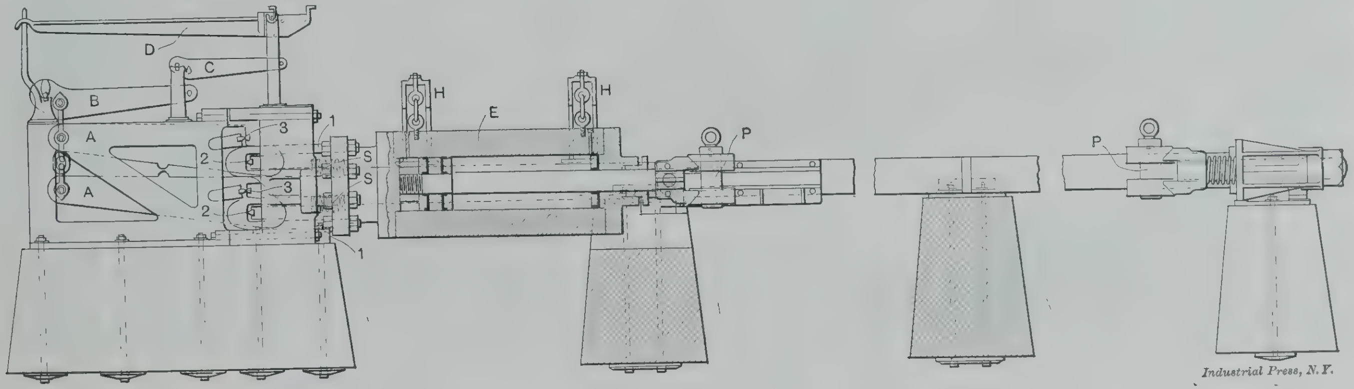


Fig. 3. Detail and Sectional View of Testing Machine.

While this particular machine is intended for specimens only 18 feet long, it may be adapted for cables of lengths as great as 100 feet, for example, in which case the plunger would be given a travel of six and one-half feet to allow for the stretch and slack in the cable. For these increased lengths the weighing and pulling end and the anchor end remain the same, with the exception of the length of the cylinder, and separating columns having a total greater length are placed between the two ends. The machine has a capacity of 800,000 pounds. The beam is arranged so that the poise is propelled by means of a screw, either by hand or automatically, as desired. The readings are by 5,000 or 10,000 pounds on the beam and 50 or 100 pound marks, as desired, are noted on a dial. The piston rod is seven inches in diameter, and the walls of the cylinder are 10 inches thick. A three-plunger hydraulic pump is furnished which operates under a pressure of 3,500 pounds per square inch. The pump is belt-driven, feeds into a reservoir to maintain a constant pressure, and is provided with a safety valve so attached that it cannot become deranged. The pump is not shown in the illustrations, but is connected directly to the pipe appearing in both half-tone cuts.

* * *

A newspaper account says the largest locomotive in the world, recently built for the Santa Fe to haul freight over the Step Raton Mountain Road, was piled in the bottom of a cañon at Seymour, N. M., July 29, under twenty-eight freight cars, which it was unable to control on the steep grade. An unusually long train was being taken over the mountain with three engines, two in the lead and the giant pushing. The train broke in two three times near Wooton, the part last time occurring two car lengths behind the second engine. The jolt started the long train back down the steep grade, the big pusher being unable to hold it. Engineer Leason whistled for brakes, and the two brakemen hurried about the task. They had tightened about twenty of the brakes, but the train was gaining headway every second, and they jumped for their lives. The train continued on its mad course for about three miles, and left the rails on a bridge 100 feet long and 50 feet high, near Seymour. The engine and all the cars piled over the structure and went plunging down the cañon.

STEAM MOTOR TRUCKS.

DESCRIPTION OF THE STEAM TRUCKS MADE BY THE MORGAN MOTOR CO.. WORCESTER, MASS.

During the past few years good progress has been made in England, France and Germany in the development of power trucks, but in America nothing worthy of note has been accomplished up to within the last two years. A number of automobiles designed to carry one or two tons had previously been built, but so far as we know none had given satisfaction. More recently, however, increased attention has been paid to the practical economy of motor-driven trucks, and it is quite certain that the number which will be manufactured and used by different firms will rapidly increase.

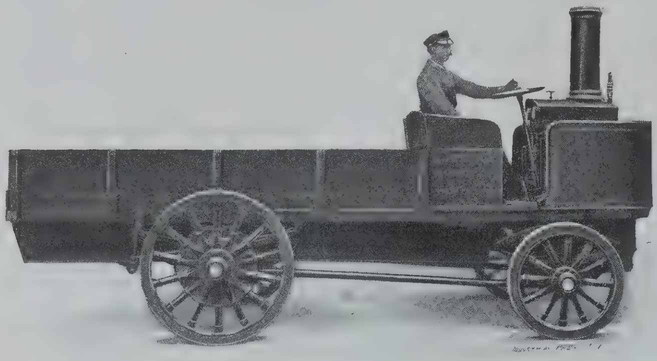


Fig. 1. Steam Truck built by the Morgan Motor Co.

One of the most interesting developments in this line in this country is the steam truck now manufactured by the Morgan Motor Co., Worcester, Mass. In the fall of 1900 Mr. R. L. Morgan, a mechanical engineer who had given much attention to automobiles in general, and commercial automobiles in particular, went to Europe on a tour of inspection. He investigated thoroughly all the trucks made upon that side of the water, and as a result, purchased, just before his return, a complete set of drawings and the rights to manufacture the steam truck then built by the Liquid Fuel Engineering Co. of England. He picked this out as the most promising machine to be found, and the one best adapted to the more exacting requirements of our roads and climate. He procured at the same time a truck which had been in use for some three years, and which had traveled some twenty odd thousand miles. This was to be a working model, and a machine upon which all experiments could be tried, with the idea that when new trucks were completed it would be known that all changes made were for the better.

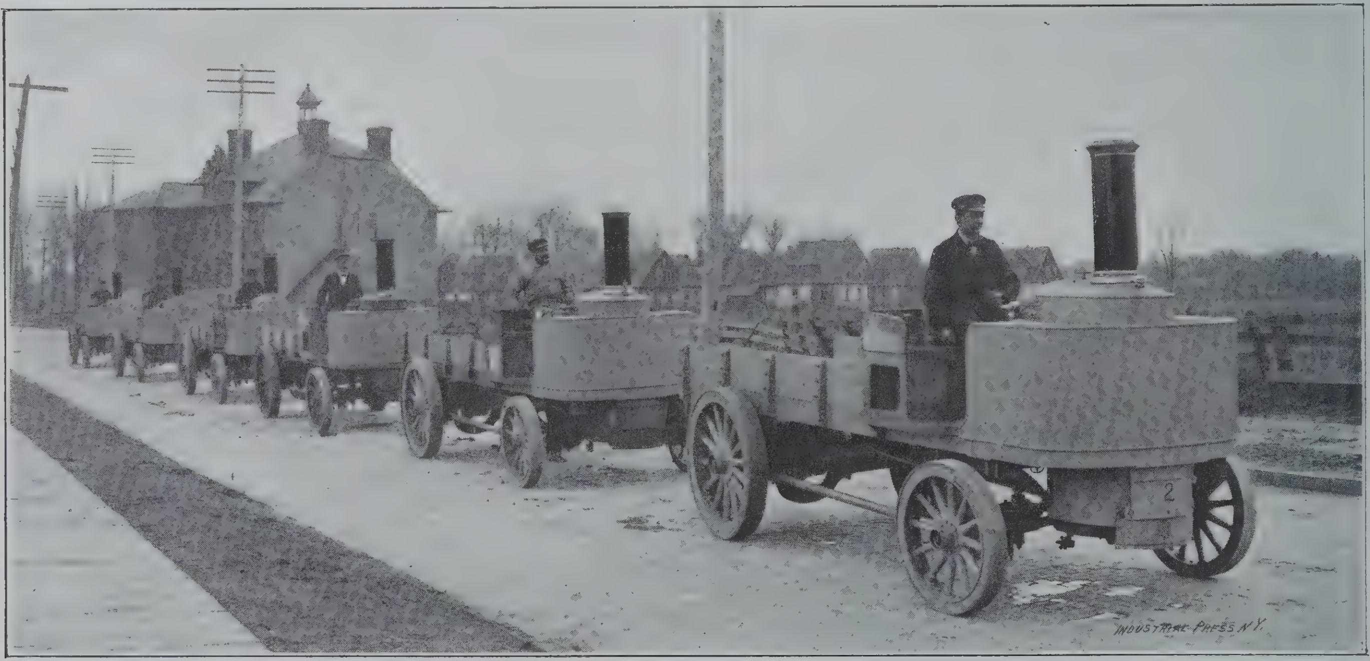


Fig. 2. Six American-built Trucks, after the Design of the Liquid Fuel Engineering Co., England.

Being at that time in the employ of the American Bicycle Co. as manager of their Toledo plant, Mr. Morgan had built there under his patents six trucks. These were started and nearly completed, when, at the beginning of the present year, he retired from the American Bicycle Co. and formed the Morgan Motor Co. The trucks were finished in Toledo, all six of them run up planks under their own steam onto cars and shipped to Worcester, Mass., where a small but up-to-date plant had been installed. All six of these trucks have been in successful operation, and through them Mr. Morgan believes he has demonstrated that hauling, which up to now has been done by horses, can be satisfactorily accomplished by steam trucks, and, not only satisfactorily, but at a cost much less than by the old methods.

In substantiation of his conviction in the matter he has sent us a brief history of the truck which was brought from England. He says: "At the time of its shipment to America it had already run some 20,000 miles. Part of that time it was working for a wholesale merchant in London, and part of the time for one of the large newspapers. While working for them the truck was run twenty-two hours a day, and its boiler was never cool from 12 o'clock Sunday night until 12 o'clock the following Saturday night. It ran this way for nearly six months. This was particularly exacting work, in that there were trains to catch, which meant the loss of considerable money if one were missed.

"On reaching America the truck was shipped to Toledo, O., where it was put into the regular service of the American Bicycle Co. It was found that the machine could easily do the work of a two-horse and a one-horse team, starting out about eight or half-past in the morning, taking an hour and a half off at noon, and being laid off by half-past four every afternoon. The machine, during that time, was frequently overloaded, and it was taken over some of the poorest roads which any American city can show. Hills are a minus quantity in Toledo, but the truck carried 6,500 pounds up a 16 per cent grade, which was the steepest that could be found.

"In the fall of 1901 the truck was taken to New York and started in the Endurance Contest between New York and Buffalo. Although it did not qualify, even at the end of the first day's run its showing was very satisfactory. The start from the club house of the Automobile Club of America was made at 7 o'clock Monday morning, and the town of Croton, which was 35 miles distant, was reached at quarter before twelve. The road contained some hills of 15 per cent grade and also some sandy stretches. At Croton, in turning out for a team near an embankment, the road gave way and let the truck down to the axles. In extricating the machine one of the boxes on the intermediate shaft was broken. The truck, however, proceeded as far as Peekskill, where the necessary repairs were made. Where the roads were hard the truck traveled as fast as 15 miles an hour, and showed itself equal to climbing a 20 per cent grade. That, however, was its limit. The machine was greatly delayed by soft roads, and many times sank to the hubs in mud. The reversing of the engine with high pressure steam on both cylinders and the rear wheels hub deep in mud was an ordinary occurrence. That, of course, meant that the truck was undergoing about as heavy a strain as could be put on it. Nothing, however, gave way. Albany was reached Saturday night with the truck in good condition. As the contest was declared off, the machine was shipped by train from Albany to Toledo. From then until the time it was shipped to Worcester, Mass., with the other trucks, it ran steadily at the Toledo factory, and it is to-day in operation in Worcester. After nearly five years of service, and after having traveled over 25,000 miles the truck is practically in as good shape as when it was turned out from the factory."

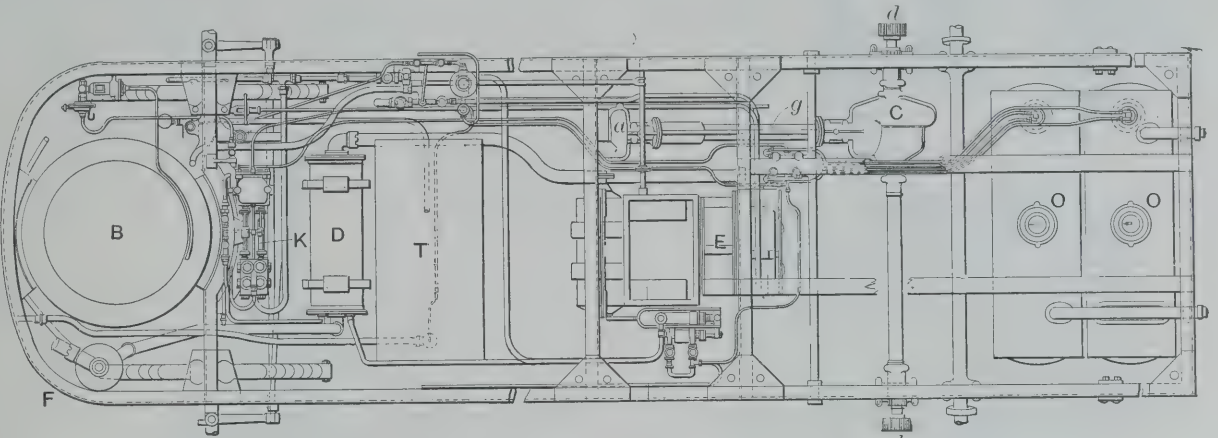


Fig. 3. Plan of Frame Showing Location of Machinery and Connections.

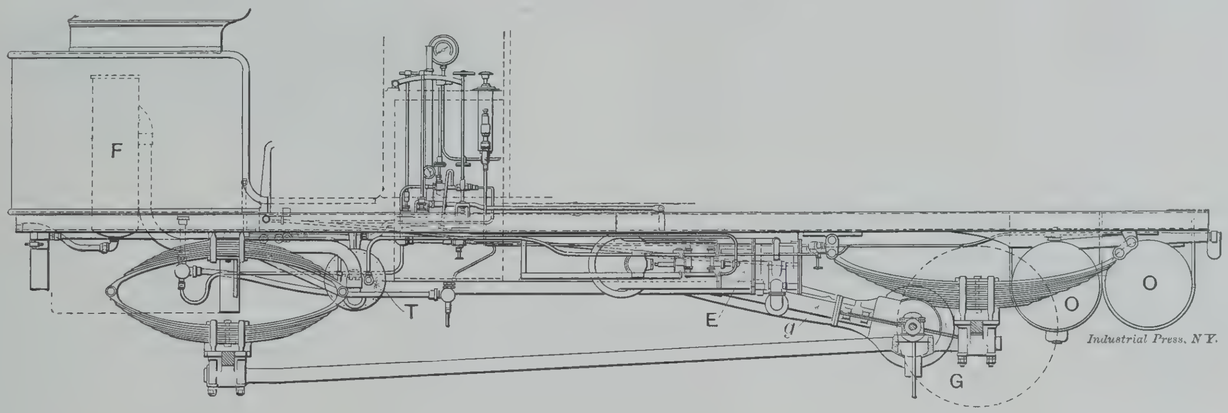


Fig 4. Side View of Frame.

The six four-ton trucks are, with the exception of a very few points, copies of the original. They are, however, a little stiffer all the way through.

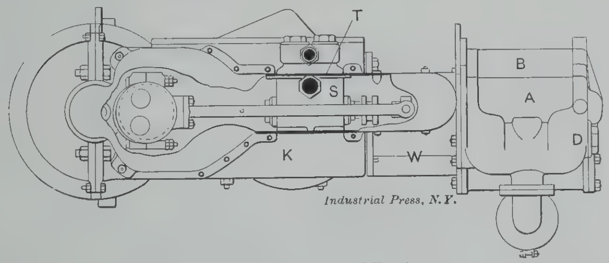


Fig. 5. Side View of Engine.

The frame is supported by elliptical springs in front and semi-elliptical in the rear, and is of 4-inch channel iron. The front axle is of 2-inch forged steel, and the rear axle of 2¾-inch. The wheels are of a special type. They have metal hubs and wooden spokes, which are set in metal spoke sockets, riveted onto a ½-inch inside steel tire. Wooden felloes and 6-inch tire for the rear wheels and 4½-inch for the front wheels, complete perhaps the strongest wheel that is at present in use for automobile work.

Fig. 3 gives a plan of the machine. The boiler *B*, which is of the water-tube type, is hung just ahead of the front axle, and also of the operator. The engine *E* is centrally located, and is tied rigidly to the main frame. Power is transmitted through beveled gears *a* and a telescopic shaft *g* to an intermediate shaft *C* on which is the compensating gear. On the new trucks there is a clutch for locking the compensating gear which is not shown in the cut. Pinions on the ends of the intermediate shaft mesh with internal gears on the rear wheels. The exhaust steam from the engine passes to the feed-water heater *D*, which contains 55 feet of copper tubing. From *D* the steam goes to *F*, which is a centrifugal separator. What steam escapes from *F* is carried to a perforated coiled pipe at the top of the boiler, where it escapes into the stack with the products of combustion. The condensed water which collects in the separator is returned to the tank *T*. This tank holds 100 gallons. The two tanks *O*, at the rear, contain fuel oil, and together hold 56 gallons. *K* is a Worthington duplex pump, which may be used for filling the boiler when the truck is standing.

The driver sits at the right hand side of the vehicle, and the auxiliary air pump, the link lever, the main throttle, and that for admitting live steam to the low-pressure cylinder, the duplex pump throttle, and also the valve for regulating the water supply, are at his right hand. The machine is steered with a lever, since it has been found that such action is much quicker than that of a wheel, and that the machine

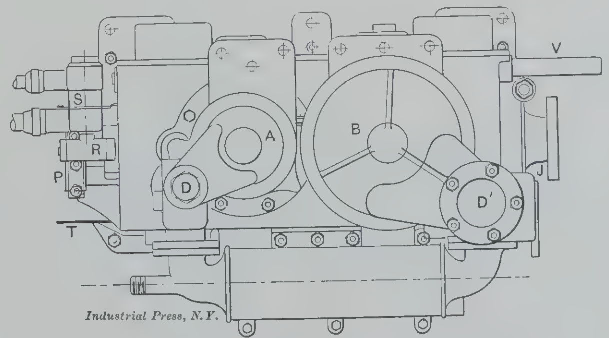


Fig. 6. End View of Engine.

is small enough to handle in that manner. Fig. 4 gives a side view of the machine.

The engine is of the horizontal, cross compound type, the cylinders being 3 inches and 6 by 5 inches. The cylinders are separated from the main case, which encloses all the working parts, by a spreader or intermediate frame which admits of the packing of the glands, both on the main case and the cylinders, without disturbing any of the other parts. It also prevents the formation of water in the engine case from leakage in the piston rod packings. The main case is made of very stiff bronze. The crossheads are of phosphor bronze and run in steel slides, and the connecting rods are of forged nickel steel. The main engine crankshaft is also forged from a single piece of nickel steel, and is made amply strong to withstand any strain which may be put upon it.

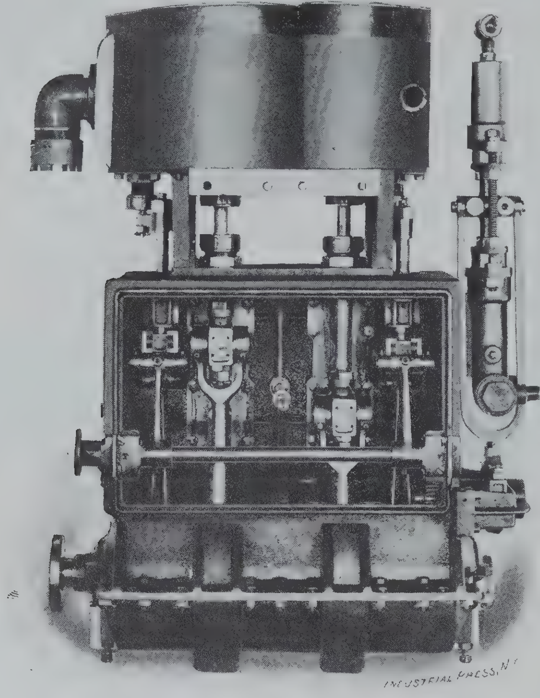


Fig. 7. Compound Engine, with Casing Removed. Cylinders, 3 and 6x5 inches.

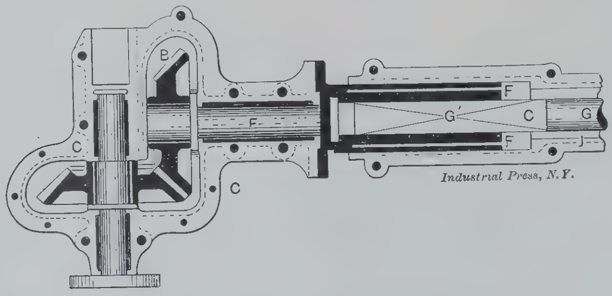


Fig. 8. Encased Bevel Transmission Gears.

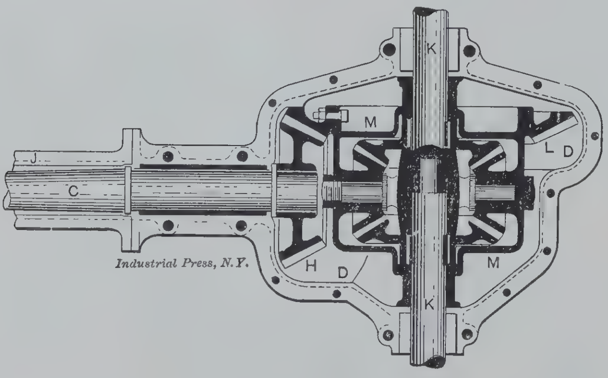


Fig. 9. Compensating Gear.

The working parts of the engine run in oil. They are easy of access, in that practically the whole top of the case may be removed by the loosening of one nut. The air and the water pumps are driven by a pinion on the main engine shaft. They are both single acting and of ample capacity for the work required of them.

Fig. 5 is a side view of the engine on the pump side. Fig. 6 is an end view from the rear. From these two cuts it will be seen that the engine is very compact.

Figs. 8 and 9 show the transmission gears, Fig. 8 being the bevel gears at the engine end, which are enclosed in a metal case and run in oil. *C* is the telescopic shaft, it being through this that the motion of the springs is taken up. Fig. 9 shows the compensating gear and also the main driving gears which are upon the intermediate shaft. The clutch for locking the compensating gear, which has been mentioned, is not shown in the cut.

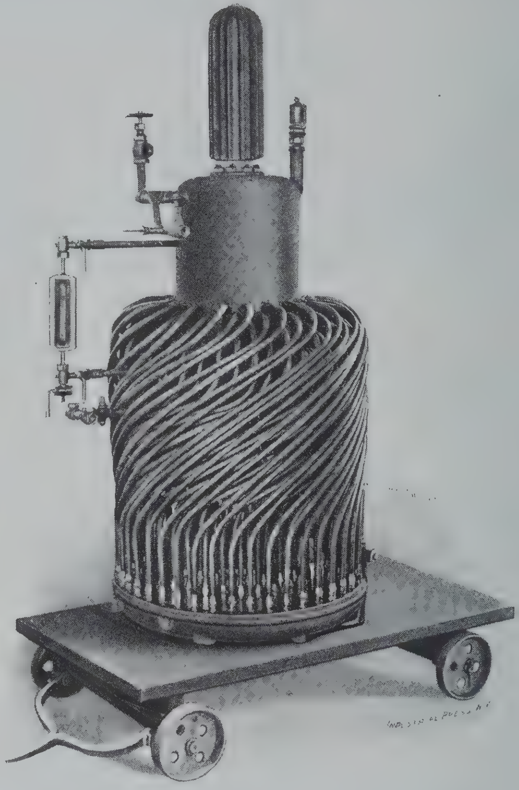


Fig. 10. Boiler with Shell Removed, showing Tubes.

Either kerosene or fuel oil may be used for generating the steam, and one mile with full load can be made on three-quarters of a gallon. The supply of oil is adjusted by an automatic regulator, very much after the pattern of those used in the ordinary steam carriage. The water tank is good for about 25 miles of steady running. The ordinary stops of the vehicle, however, in a day's work will considerably reduce the mileage per tank.

The average speed of the truck is from six to ten miles per hour, and it can be handled at these speeds even in crowded streets. Given a good level road and no traffic twelve miles an hour can be made. This is an important point when figuring the economy of the machine, in that it means that the truck hauling as much as would make a load for one two-horse team can do the work of three or even four. Furthermore, it is possible to run the machine 20 to 22 hours a day, whereas a horse-drawn vehicle can be operated at the outside but 10 hours.

* * *

In the discussion at a meeting of the Engineers' Society of Western Pennsylvania, the fact was brought out by Peter B. Wight, consulting architect, that corrosion in steel structures is not as serious as supposed. He said' "In an extreme case I have seen I-beams taken out of a building which were put in in 1858, and were exposed to leaking water from 1858 to 1870. That is 12 years. During those years I do not think there was a particle of corrosion in the parts of the beams not exposed to leaking water. In the parts exposed to leakage which I measured there was not more than 1-16 of an inch of loss on both sides. They were beams used to support a water-tank in Chicago. A water-tank is always sweating and is always damp. In the center I could not see any deterioration at all, and the beams were just as good as when they were put in.

ENGINEERING REVIEW.

A SYNOPSIS OF CURRENT TECHNICAL LITERATURE.

Mr. W. C. Leland, a machinist of Brooklyn, referring to our inquiry some time ago for a spring made of a substance which would not be affected by heat, says the *American Machinist*, has sent us some pieces of mica arranged to act as a flat spring, and he says that a mica spring continues to act as a spring when exposed to very high temperatures. The specimen sent us acted as a spring when held in a gas flame and continued to so act as long as the test was made. Of course, as many layers of mica may be superposed as is necessary to get the desired thickness, and for experimental purposes at least we would imagine that such a spring may be quite useful.

The boiler of a B. & O. locomotive exploded at Ravenna, Ohio, July 23, killing the engineer. The boiler was lifted vertically off the frames and truck, leaving all the running gear and cylinders on the track. It was carried forward directly over the track a distance of 70 feet where the front end struck the ties and buried itself five feet in the ground, breaking a 90-pound rail squarely in two. The fireman asserts that the water glass showed three gages of water and that the injector was working at the time of the explosion. The illustrations of the wreck published in the *Railway Age* show that the crown sheet gave way. The crown sheet showed that it had been burned; the crew claimed that this was due to a fire being started in the boiler at some time previous when there was no water in the boiler! An engine of the same class belonging to the same road exploded three days later at Connellsville, Pa. The boiler first mentioned bore general evidence of structural weakness and neglect.

EVOLUTION OF THE COAL CAR.

Mr. F. F. Gaines, M. E., of the Lehigh Valley R.R. exhibits photographs in the *Railway Master Mechanic*, which show graphically the growth of the coal car on that railroad during the past 36 years. The first cars of 6-ton capacity were built in the summer of 1863. Their weight was 3½ tons, and capacity 12,000 pounds. The next step was in 1877, when 20-ton cars were built, with a capacity of 40,000 pounds, and an average weight of 20,530 pounds. In 1884 came the 25-ton cars, with a capacity of 50,000 pounds, and weighing about 23,590 pounds. The first 30-ton car was built in May, 1887, with a capacity of 60,000 pounds, and about 27,490 pounds' weight. By the early fall of 1899 the size of cars had increased to 40 tons, the load 80,000 pounds, and weight about 36,650 pounds, and in November of 1899 were built the 50-ton all-steel cars, with a total capacity of 100,000 pounds, and weighing 37,420 pounds.

PROPERTIES OF SELENIUM.

In reply to a correspondent's inquiries regarding the properties of selenium, the *Scientific American* says that it is not a metal but an elementary substance which in its ordinary condition is a brittle solid of a glassy lustre and fracture and a brown color. It melts at about 430 degrees F., vaporizes at about 1,300 degrees, and burns with a blue flame, giving out an odor resembling that of putrid horseradish. Ordinary selenium is a very poor conductor, having an electrical resistance 37,500,000,000 times that of copper. When annealed for several hours at a temperature just below its melting point, with subsequent slow cooling, it forms a crystalline substance with a lower resistance. It is now sensitive to light. Its resistance is reduced, not increased, in proportion to the square root of the illumination; and also the effect is greater with a high electromotive force than with a low one. Narrow strips of annealed selenium are formed between the edges of broad plates of metal, so that the cross section is considerable, and thus the resistance is reduced while the area exposed to light is considerable. This is a "selenium cell." When the light strikes it, its resistance may be reduced as much as one-half. A cell whose resistance in the dark was 300 ohms dropped to 150 ohms in the light. Such a cell is not a generator of electricity, but a measuring instrument for determining the intensity of light.

FRENCH LOCOMOTIVE PRACTICE.

In the July issue there appeared a brief note on the prevailing American practice of machining parts of machines which do not of themselves require to be machined, but which is done to save time in erection or subsequent operations. In the description of the building of a first-class locomotive at the famous Belfort locomotive works in France published in the *Engineer*, statements are made that indicate such practice is not followed there. The sides of the locomotive frames are not ground or planed, but are left rough. Consequently when the frames and motion work is erected it has to be done entirely by reference to stretched lines and gages. Lines and special squares are also used to test the parallelism and squareness of the frames. In these shops milling machines are generally employed for surfacing operations, in preference to shapers, planers and slotters. Tapping staybolt holes and reaming rivet holes is done by power, the power being conveyed by means of rigid splined shafts driven by bevel gears. Flexible shafts or pneumatic motors do not appear to be used. The staybolts are made of either manganese bronze or copper, preferably of the former metal.

VANDERBILT FIREBOXES COLLAPSE BECAUSE OF DEFECTIVE CIRCULATION (?)

Charles F. Prescott, a locomotive engineer on the Santa Fe Pacific R. R., has communicated to the *Railway Age* a suggestion which he believes would, if adopted, greatly improve the Vanderbilt boiler, especially when used with fuel oil. Several of the Vanderbilt fireboxes have collapsed in service, but not because of structural weakness so much in his opinion as because of defective circulation. He has noticed that with two full gages of water the water level will fall to a scant gage when the throttle is opened and the water will not return to the normal level until the throttle is closed. The contention is that the fireboxes of these boilers repel the water in all directions, bottom as well as top, when burning liquid fuel, and that as a consequence the top portion of the firebox is often left bare. A circulation pipe is advocated having sufficient capacity to carry the water from the front end of the firebox by an exterior route, the circulating pipe being connected to a mud drum in front and the lowest part of the firebox at the rear with, possibly, intermediate connections with the barrel of the boiler between these points. These boilers are said to be poor steamers, although they have large heating surfaces; so the suggestion that defective circulation may be one cause of the trouble is worthy of consideration even if the means suggested for its improvement is not.

BOATS BUILT SO AS TO BE TRANSPORTED IN SECTIONS.

It is always a cause for considerable wonder to the average person as to how the large steel steamships which ply the inland lakes have been constructed, since they obviously must be carried to the waters on which they are to ply, in sections small enough to be placed on a railroad car. Lately there was a description in *Marine Engineering* of the process of erecting a boat that had been shipped in sections to Lake George, N. Y. This was reprinted, in part, in the Philadelphia *Record*, and called out a communication to that paper by J. A. Robinson, of Marshallton, Del., with regard to early work of this description. His father, Thomas M. Robinson, was engaged in the years 1850-57 in building side-wheel steamboats at Newcastle, Del., which were afterward shipped to California. He writes:

> The hulls were wood, and two of the boats, after having been launched and given their trial trips, were taken apart and loaded on sailing vessels and sent around Cape Horn to California, where they were rebuilt. Had they been built in the regular way, with heavy rib timbers and planking spiked or treenailed to them, this would probably not have been possible. These hulls were built somewhat on the principle

of a hooped barrel. They were not "whale backs," but were flat-decked, as other boats. Iron or copper hoops were used outside of the planking in a manner that not only did away with a great deal of timber in their construction, but avoided the necessity of calking the seams. This style of building originated with my grandfather, who built several small sailing vessels before my father entered into the building of larger sailing vessels and steamboats, and on account of the accuracy required in building such, the art virtually died with my father, no one else having made a success of it.

These boats sent to California fifty years ago may even at this time be in service, as two others built in the early 60's are in comparatively good condition and still in service on the Chesapeake Bay.

Mr. Robinson contends that this was a greater feat than building iron or steel boats for service in inland waters, inasmuch as the latter are merely set up in the builders' yards and not launched as were the builders' boats.

HOW TO MAKE SMALL CASTINGS WITHOUT A CUPOLA.

The English Mechanic, 1902.

The *English Mechanic* says that many mechanics have no doubt heard of a somewhat mysterious substance known generally by the name of "thermit." This is nothing more than a mixture of aluminium and an oxide of iron mixed in proper proportions. If a portion of this mixture is raised to a higher temperature, the aluminium extracts the oxygen from the oxide of iron, reducing the iron to the metallic state, and becoming itself oxidized to alumina. The heat resulting from this oxidation of the aluminium, even though the iron is deoxidized, is so great that not only is the reaction propagated through the whole mass of thermit present in a very few seconds, but the resulting pure iron and alumina slag are quite fluid, and have a temperature of about 3,000 deg. Cent. (5,400 deg. Fahr.). Iron at this temperature is so unnecessarily hot that 20 to 25 per cent. of clean wrought-iron punchings or scrap may be added to the thermit, and it, too, will be melted, and so about double the yield of iron, since thermit produces about half its weight of iron.

In order to make use of thermit for our special purpose, the required quantity is put into a crucible, which is made simply of sheet-iron with a refractory lining. There is a small tapping-hole at the bottom of the crucible, which is covered with a wrought-iron punching about as big as a silver quarter dollar and perhaps ⅛-inch thick, this again being covered with ½-inch or so of dry sand. The thermit, mixed with the wrought-iron scrap—which, however, must be perfectly free from oil—is then placed in the crucible, and about half a teaspoonful of a special igniting powder is placed in a little heap on the top. The crucible is supported in some convenient way, with the tapping-pole directly over the mould. A small iron rod is supported by the aid of a lever, so that it can be jerked up through the hole and displace the iron blank when the iron is ready to run. When all is ready, a fusee is pushed into the igniting mixture. The reaction may be watched through a dark glass (some protection to the eyes being necessary), and as soon as a quiet glowing mass is seen, free from bubbles, the time has arrived for tapping the crucible. The rod is jerked up, and the iron immediately runs into the mould. The lever should be quickly jerked to one side; otherwise the end will be melted off by the hob iron.

A few words may be added as to the mould. The ordinary sand mould answers well with small castings. It is best to dry it thoroughly, and it is well to paint the surface with a mixture of blacklead and water while hot. It is well, where possible, to lead the runner into the mould at the bottom, and to provide a riser for the escape of a small amount of metal. Further, as the slag formed occupies about three times the volume of the thermit iron or about one and a half times that of the total iron, it is well to provide a channel outside the mould in loose sand, by which the slag and any superfluous iron may escape.

Where it is required to fill a defect in a casting, or to melt a piece of iron for any purpose onto a casting or a forging, a mould must be extemporized and placed in position, and the iron run in so as to pass over the metal, which it will immediately melt on the surface, and with which it will unite. There is one precaution here, however, which should not be overlooked: if the mould is warm and is not absolutely dry, it would be sure to deposit moisture on the cold iron, which might lead to a serious accident. It is a precaution, therefore, whenever running thermit iron on cast iron, steel, or wrought iron, to warm the metal first to a temperature which is at least hot to the hand, to prevent such condensation of moisture. The thermit iron produced as described above works in the lathe and under the file like the mildest steel.

NEW EDISON CEMENT PLANT.

Scientific American, 1902.

The extensive and growing use of concrete construction in almost all branches of engineering work makes the announcement of the starting of the large Edison cement plant at New Village, near Stewartsville, Pa., of general interest, especially as the new process is promised to greatly cheapen the price of Portland cement, rumor having it that the first cost will be so little as fifty cents a barrel. A force of over 300 men will be employed from the start, which is expected to be materially increased when the business is under way. Regarding the new process and the plant the *Scientific American* says:

"After conceiving the idea of improving upon the old process and discovering an inexhaustible deposit of cement rock at Stewartsville, Mr. Edison formed a company. This was more than two years ago, and since that time about sixty-six men have been at work constructing the twenty-seven buildings and installing the machinery. The plant, which is one of the largest of its kind in the United States, covers a space half a mile long, and one-quarter of a mile wide. It has thus far cost over a million and a half dollars. The machinery is built for a capacity of 10,000 barrels per day; but the buildings were made to accommodate half that amount at the start, and if the business proves successful the plant will be increased to its fullest capacity in a few years. There are twenty-seven buildings and the roasting-house is separate from the others. All the others are connected by a deep tunnel half a mile long, fifteen feet wide and twenty-five feet deep. The stock-house contains two 600-foot corridors, one above the other, and connected by big flues. There the cement rock will be roasted and prepared for the refining process. From that building starts the tunnel mentioned. The raw material will be conveyed by means of an electric railroad through the tunnel from the stock-house to the crusher, and thence to the dryer. The tunnel is made of solid rock walls and paved with concrete. The dryer is a simple stone shaft twenty feet square and forty feet high. Inside is a series of drying pans.

"The crusher is located in a building four stories high, the two sides being of solid masonry, ten feet thick at the bottom and five at the top. The floors are of steel construction. The machinery is capable of crushing 25,000 barrels of cement rock every twenty-four hours. The rollers have a pressure of 100,000 pounds to the square inch. In order to get results Mr. Edison made use of a discovery by means of which, with the aid of pulleys worked in connection with air compressors, he could get the great pressure directly upon the steel rollers with less than 1,000 pounds pressure on the bearings. All the cement rock will be transported through the tunnel as it is moved from one building to another. The raw material is received at the roasting-house and there the cement rock will be roasted and prepared for the secret refining process invented by Edison, and which is expected to revolutionize the cement industry. Before the product is again handled by hand it will automatically travel several miles through the many buildings. One hundred and twenty-five electric motors are used in the plant. When the last stage of the process is reached the cement will flow into barrels, in a building through which several railroad tracks pass, thus permitting the barrels to be loaded as fast as filled. All the buildings are of steel, covered with corrugated iron and painted black."

HYDRAULIC ELEVATORS FOR OFFICE BUILDINGS.

Engineering News, July 31, 1902, p. 74.

In an article in the *Engineering News* on the selection and installation of hydraulic elevators, Henry D. James says that elevators for office buildings are generally made 5 or 6 feet square and that a load of 75 pounds per square foot of floor area must be allowed for in all passenger elevators. Also that one elevator, approximately, is required for each 25,000 square feet of floor area. This ratio, however, varies greatly according to the location of the building, the demands on the service being much heavier in the vicinity of stock exchanges than in some other localities. The speed depends on the height of the building; 300 feet per minute being fast enough for a ten or twelve-story building, and double that, or 500 to 600 feet for twenty-story buildings. As a matter of fact, however, it has in many cases been found advantageous to reduce this to 400 feet per minute for local elevators, as the lower speed was more agreeable to the passengers and the service nearly equally as efficient since more time is consumed in stops than is taken by the vertical travel. Of course higher speed is desirable for express service. Hydraulic elevators are made with both vertical and horizontal cylinders. Each type has its advantages and disadvantages. The vertical type has a lower gear, therefore less friction, and takes up less floor space. The cylinder can be placed in the elevator shaft back of the car so that only the pumping plant need be placed in the basement. The cylinders rarely exceed 40 feet in length, and generally their length is not more than 30 feet. Where the horizontal cylinder machine is used, it is placed in the basement, but a number can be stacked one on top of the other so that the floor space required under these conditions is not great. All horizontal machines require a separate counterweight to partially balance the weight of the car and the same is true of all vertical machines where the ratio of the gear is greater than 4 to 1. The unbalanced weight of the car must be sufficient to overcome all friction of the gear and cause the car, with the weight of the operator, to descend at about the same speed at which it is required to rise. The modern office building elevator car often weighs from 3,000 to 4,000 pounds, which requires 500 pounds or more unbalanced weight. Both types should have a chain attached to the bottom of the car to compensate for the weight of the rope lifting the car. The object of the chain is to compensate for the weight of the rope as it shifts from the car to the machine. Thus when the car is at the bottom of the shaft, all the weight of the rope is added to that of the car and *vice versa*, when it is at the top none is included. The chain exactly compensates for the varying load of the rope. In some cases the chain is omitted and a column of water exhausting against an increasing back pressure is used to compensate for the weight of rope; but this is not recommended. There should never be less than four lifting ropes for a passenger elevator attached to a hydraulic machine, and these should have a factor of safety of ten to one. Wrought iron rope with a center of hemp is preferred to steel, strangely enough. The reason given for this preference is that wrought iron rope is more pliable than steel, and that there is no guarantee if steel rope is used in the start that it will not be replaced with iron by the repair men, so it is considered safer to calculate on iron in the beginning. In addition to the regular safety stop placed in the bottom of the car, stops should be provided at each limit of the travel so that cars will be automatically stopped even if the attendant neglects to do so. Elevator cars are often provided with an emergency lever which enables the operator to grip the vertical guides attached to the sides of the elevator well in case an accident occurs and the ordinary device fails to work. Speed controllers are also employed which automatically check the speed of a car if it exceeds a certain limit. The "air cushion" is another device employed for cases of extreme emergency. It is not effective unless the velocity is high. Tests have shown that it will save life in case of a free fall, but it must not be considered as a substitute for the other safeties commonly employed.

POWER FOR ELECTRIC CRANES.

Journal Society of Western Engineers.

The following data on the power required for electric traveling was given by Mr. S. S. Wales at a meeting of the Engineers' Society of Western Pennsylvania.

An electric crane is divided into three general parts—bridge, trolley and hoist, each of which has its own motor and controlling system, and each subjected to different conditions of work.

For the bridge, where the ratio of axle bearings to diameter of wheel is between one to five and one to six, the following table will answer our purpose for weights and traction for different spans:

Let L = working load of crane in tons.
W = weight of bridge alone in tons.
w = weight of trolley alone in tons.
S = speed in feet per minute.
P = pounds per ton required.

Span	W.	P.
25 ft.	.3L	30 lbs.
50 ft.	.6L	35 lbs.
75 ft.	1. L	40 lbs.
100 ft.	1.5L	45 lbs.

For the trolley we would assume the weight and traction as shown in the following table:

L.	W.	P.
1 to 25 tons.	.3L	30 lbs.
25 to 75 tons.	.4L	35 lbs.
75 to 150 tons.	.5L	40 lbs.

Now the power required for bridge will be:

$$\frac{(L + W + w) \times P \times S}{33{,}000} = \text{H. P.}$$

which result will be used in connection with the motor characteristic to determine the gear reduction from motor to track wheel. As the nominal H. P. rating of a series motor is based on an hour's run with a rise of 75° C. above the surrounding air and as conditions of bad track, bad bearings or poor alignment of track wheels may be met with, 1½ times the above result should be taken as the proper size motor for the bridge.

For the trolley the power required would be:

$$\frac{(L + w) \times P \times S}{33{,}000} = \text{H. P.}$$

which will be used for speed and gear reductions, but 1¼ times this should be used for size of motor.

For hoist work we cannot have so large margin of power, as the variation from full load to no load may imply a possible dangerous increase of speed, and unless the crane is to be subjected to its maximum load continuously or is to be worked where the temperature of the surrounding air will be high, it is safe to use the size found by assuming 1 H. P. per 10 ft. ton per minute of hoisting. This is nearly equal to assuming the useful work done as 60 per cent of the power consumed.

As an illustration, let us take a crane of 50-ton capacity, lifting speed of hoist 15 feet per minute. Bridge to be 70 feet span and to run 200 feet per minute with load. Trolley to travel 100 feet per minute with full load. On the foregoing assumption the bridge would weigh 50 tons and require 40 pounds per ton for traction, and the trolley would weigh 20 tons, and require 35 pounds per ton for traction.

The power for the bridge would be:

$$\frac{120 \times 40 \times 200}{33{,}000} = 29 \text{ H. P.}$$

and the size motor 1½ times this would give 43½ H. P. or 50 H. P., this being the nearest standard size, and the specification should read not less than 50 H. P. motor to be used for bridge travel.

Assuming Westinghouse motors to be used, as they are more commonly known in this district (Pittsburg), this would call for a No. 38—50 H. P. railway motor. By referring to characteristic sheet for this type furnished by the Westinghouse Company we find that at 29 H. P. this armature will run 612 revolutions per minute, which, when the diameter of the track wheel is known, will give the gear reduction needed.

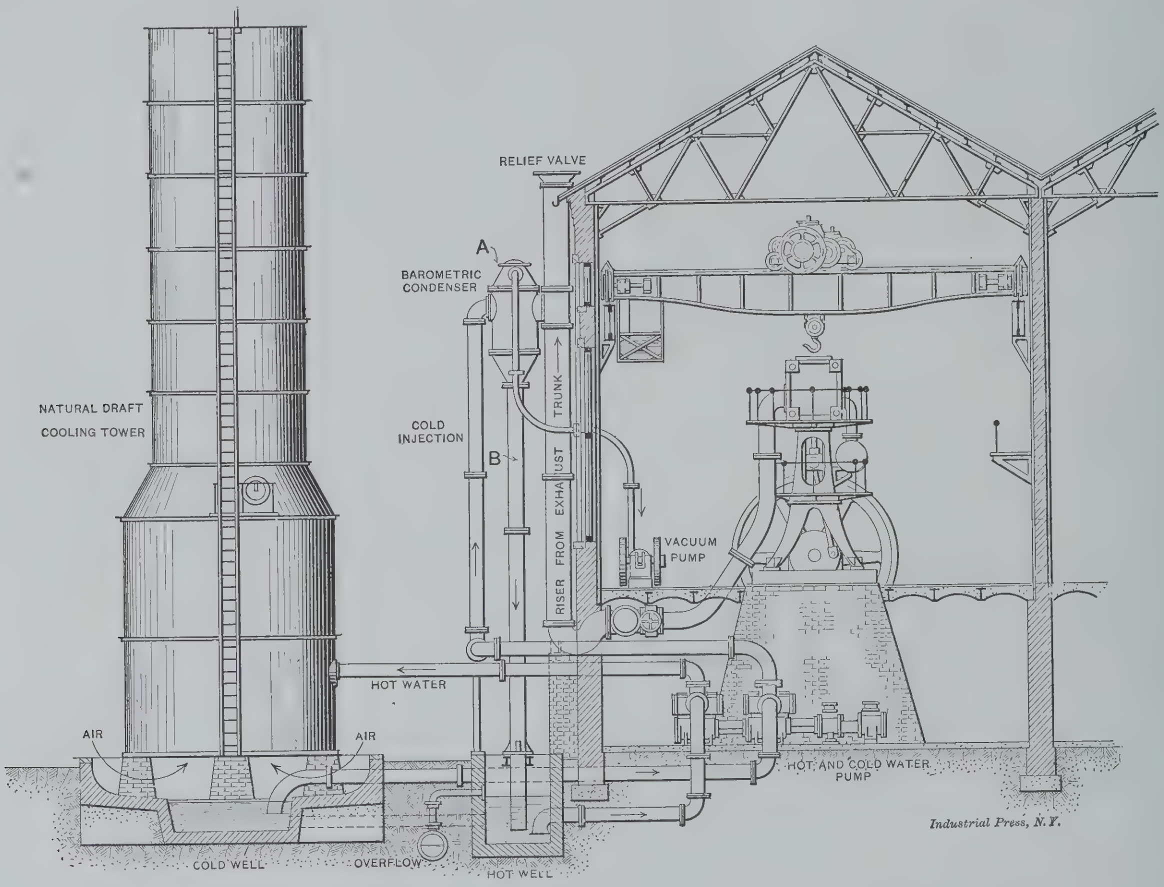
Similarly the trolley will require $\frac{70 \times 35 \times 100}{33{,}000} = 7.43$ H. P. and the size motor required will be 1¼ times this, or 8.28 H. P. The next larger standard size motor is 10 H. P., and the specification would read not less than a 10 H. P. motor to be used. The characteristic of a Westinghouse 10 H. P. motor shows that the armature will run 820 revolutions per minute at 7.43 H. P.

The hoist would require $\frac{50 \times 15}{10} = 75$ H. P. and would be specified not less than 75 H. P. motor to be used on the hoist. The next standard size Westinghouse motor suitable for crane service is rated at 80 H. P. at 220 volts and the armature speed at 75 H. P. is shown on the characteristic sheet to be 460 revolutions per minute. The required power will of course be modified by the requirements of special cases, the use of rope or chain, whether the reduction is made mostly in the chain or in the gearing, etc., but still they will give reliable results to the user.

CONDENSERS AND COOLING TOWERS FOR THE POWER HOUSE OF THE NEW YORK SUBWAY.

Street Railway Journal, August 15, 1902.

New York City will soon add to her list of very large power plants another one which is being built to operate the Rapid Transit Subway now in process of construction. The engines of all these large power plants, are, of course, condensing, but a large percentage of the gain effected by the use of condensing engines is offset by the great cost of condensing water. The 50,000 horse power plant of the Metropolitan Street Railway and the 65,000 horse power plant of the Manhattan Elevated Railway, use surface condensers and salt water from the East River. Theoretically the use of a surface condenser should enable the condensation to be used over and over again in the boilers, it being only necessary to replace the small losses occasioned by leakage in the system. This would make such a plant as either of those named practically independent of the water system of the city, as the daily amount of fresh water required to replace the leakage would be comparatively small. As a matter of fact, however, it has not been found feasible to use the condensation for feed water to the boilers, so it has to be thrown away and fresh water drawn from the mains for boiler feeding. This is on account of the practical impossibility of eliminating the lubricating oil from the condensation when such large quantities have to be handled. To use feed water contaminated with lubricating oil is both unsafe and uneconomical, the latter on account of the greatly increased boiler repairs made necessary. It follows, therefore, that if the condensation cannot be used for feed water there is no need for using surface condensers which are bulky and expensive to keep in repair. Consequently in the new power station for the Subway the type of condenser variously known as the injector, siphon or barometric condenser will be used in conjunction with a cooling tower, both condensers and towers being of Alberger type.



Industrial Press, N.Y.

Section of New York Rapid Transit Subway Power House, showing Atmospheric Condenser and Cooling Tower.

The illustration taken from the *Street Railway Journal* shows the arrangement of the barometric condenser and the cooling tower, which in this case will be made for natural draft. The condenser *A* in this type of apparatus must be located at least 34 feet above the level of the water in the hot well in order to get the greatest possible vacuum, since the atmosphere will support a column of water of this height at the level of the sea. The cold injection water mixes with the exhaust steam as it comes from the engines and of course condenses it, leaving a vacuum in the apparatus. No pump is required to remove the condensing water from the condenser, since it will flow down the pipe *B* against the atmospheric pressure. An air pump is required, however, to remove the entrained air carried into the system which, if not removed, would impair the efficiency of the system and finally destroy the vacuum entirely. The water from the hot well is pumped to the top of the cooling tower (usually built about 80 feet high) where it is allowed to trickle downward over boards of cypress arranged in a regular manner so as to provide uniform flow of the sheets of water and their exposure to the air. During the passage of the water downward it comes in contact with the cool draft of air ascending the interior of the tower, which cools it to approximately the same temperature by the time it reaches the cold well at the bottom. In this way the cooling water is used over and over again, the loss being that which evaporates and is carried away by the air during the cooling process.

The power house for the Subway lines will be built to contain twelve engines of a rated capacity of 7,500 horse power each, at best efficiency, with a maximum capacity of 11,000 horse power each. Eight of these engines will be built by the Allis-Chalmers Company. They will be of the same general type as those being put in the Manhattan Elevated Railway power plant. Each engine consists of two component engines, operating on one shaft, with a 5,000-kilowatt alternator between the engines. Each of these component engines will have a vertical low-pressure and horizontal high-pressure cylinder acting on the same crank. The cranks at opposite ends of the shaft are located 135 degrees apart. The high-pressure cylinders are to be 42 inches in diameter and 60 inches stroke, and the low-pressure cylinders, 86 inches in diameter by 60 inches stroke. The engines will operate with 175 to 200 pounds initial pressure, and at 75 revolutions per minute. The high-pressure cylinders will have poppet valves, and the low-pressure cylinders, Corliss valves. The object of the poppet valves in the high-pressure cylinders is to insure the successful operation of the valves without excessive use of oil at high steam temperatures. It is expected that they will operate successfully with steam superheated to 500 to 550 degrees F.

ROLLING MILL DRIVEN BY A GAS ENGINE.

Iron Age, August 7, 1902, p. 19.

There are magnificent installations of gas engines in Germany, but thus far it has been understood that the gas engine, in large units, has been employed exclusively in two directions, that of driving blast furnace blowing engines and in operating the dynamos for the electric service at furnaces, steel works and rolling mill machinery. Of course the furnaces have had the incentive of very high fuel prices to urge them to a thorough utilization of the coke charged into their blast furnaces. Yet with all that credit must be freely accorded to them for the energy and skill which they have brought to bear upon many perplexing if minor problems involved.

It is interesting to note that they have gone a step further, and with apparent success, by employing the gas engine, using waste blast furnace gas, for driving roll trains. An account of such an engine, which has been in regular operation at a German mill since April, 1901, is given in a recent issue of *Stahl und Eisen*. Of course no attempt has been made to apply a gas engine to those requirements in rolling mill work in which sudden and heavy fluctuations in power are frequent. But the claim is made that it may be very advantageously used to supplant flywheel steam engines for driving sheet, rod and bar mills. The particular gas engine described is a horizontal tandem flywheel four-cycle engine coupled direct to the train. It was built by the Augsburg & Nuernberg Company, and at a speed of 120 revolutions develops 600 to 700 horse power. The two cylinders are 35.4-inch bore and have a 39.4-inch stroke, the diameter of the flywheel being 21 feet. The regulation is effected by a mixing valve. This latest development of the gas engine into rolling mill works is a further step in putting those localities that suffer from high fuel cost upon a closer parity with the sections blessed with cheap coal.

REMARKABLE DRILLING FEEDS.

American Machinist, July 24, 1902.

The Bickford Drill & Tool Co. have found feasible unprecedented rates of feed for ordinary commercial twist drills when used in their radial drills. The remarkable results attained are largely attributed by Mr. Norris to the design of the radial arm of these drills, which is made in the form of a complete tube instead of having one side open as in the ordinary form of construction. A complete tube is, of course, much stiffer as regards torsional stress than a tube having one side cut away when both have the same amount of metal. The torsional stress on a radial arm is very severe when driving large drills since the drill spindle is offset by the center of the radial arm. Lack of stiffness causes spring and chatter which breaks drills at far lower rates of feed than would otherwise be the case if the arm was rigid. It is pointed out, however, that the quality of twist drills now made may be considerably superior to those of a few years ago when the Morse Twist Drill & Machine Co. made out its well-known table of drill feeds. The rate of feed for a ¼-inch drill established by the Morse people is .005 inch per rotation of the drill and for a ½-inch drill .007. The Bickford people find it feasible to increase the feed of these drills to .025 and .035 inch respectively, or five times as great. A test of a ⅜-inch drill is given in which the drill was run 267 turns per minute with .064 inch feed. This rate of feed is equivalent to 17 inches per minute, yet the drill stood the test for a depth of 3 inches without breaking. A 1¼-inch drill stood a feed of .072 inch in steel but broke when the feed was increased to .10 inch; a 1 9-16-inch drill with hand feed cut chips 9-32 thick, of which a photograph is shown; a 4-inch drill was driven into solid .45 carbon steel, at the rate of 1¼ inches per minute or 6 feet 4 inches per hour, the feed being .072 inch and speed 17.68 turns per minute; and so on. The following table gives the turns per minute which the Bickford Co. regularly use when drilling cast iron:

Size of Drill	Revolutions per Minute.	Peripheral Cutting Speed Feet per Minute
½	267	35
⅝	222	36
¾	184	36
⅞	153	35
1	128	33
1⅛	106	31
1¼	88	29
1½	73	28
1¾	61	28
2	51	26
2¼	42	25
2½	35	23
2¾	29	21
3	24	19
3¼	20	17
3½	17	15

GERMAN LOCOMOTIVE PERFORMANCE AS TESTED BY VON BORRIES.

Railroad Gazette, August 8, 1902, p. 628.

The following table gives the results of some experiments made by Herr von Borries for the purpose of comparing the performances of three classes of engines: (A) A four-coupled, eight-wheeled, four-cylinder compound; (B) an engine of similar build to that of (A), but having two cylinders and using steam superheated to about 300 degrees C. (592 F.); (C) an older type of four-wheeled, eight-coupled, two-cylinder compound.

The run in each case was for a distance of 77½ miles and back, at an average speed of 55 miles per hour. The load ranged from seven to nine coaches, according to the rated capacity of the engines.

	Engine.		
	A.	B.	C.
Weight of locomotive, tons.	53.0	52.3	47.6
Grate area, sq. ft.	24.7	24.7	24.7
Heating surface, sq. ft.	1,270	1,140	1,345
Superheating sur., sq. ft.	..	.301	..
Boiler pres., lbs. per sq. in.	200	170	170
Horse power developed	879	809	755
Coal per H. P. per hour	2.31	2.53	2.55

The four-cylinder compound (A) proved the most powerful as well as the most economical engine. The two-cylinder engines of both types were practically equal in efficiency. It is stated that the four-cylinder engine ran remarkably smooth.

CONCRETE PILE CONSTRUCTION.

Railroad Gazette, August 15, 1902, p. 645.

A system of concrete pile construction has lately been perfected by Mr. A. A. Raymond, of Chicago. The method involves driving into the ground a sheet-iron shell of the size and shape of pile desired. A tapered steel core is used to accomplish this, the shell being fitted over this core and the whole driven as the ordinary wooden pile. The construction of this core is such that it may be contracted after the proper depth is reached, and withdrawn from the shell. The core is in three parts, an outer shell in halves, and a central tapered part having a head, the whole being held rigid by keys. When it is desired to withdraw the core the keys are removed, permitting the central tapered part to be raised a sufficient distance to allow the shell to collapse slightly, when the whole may be easily lifted out. The shell is then filled with concrete, which is carefully and continuously tamped as it is fed in, to prevent the formation of voids.

In a trial of this system made in Chicago the tapered steel core was 20 feet long, 18 inches in diameter at the butt and 6 inches at the point. The hammer weighed 2,200 pounds and the penetration for the last few blows was but an inch to the blow, with a fall of 25 feet. An oak pile 12½ inches at the butt and 10 inches at the point had a penetration of 5½ inches for the last blows, using the same hammer and drop, and driven only a few feet away. It was computed from these tests that the wooden pile had a carrying capacity of 17,000 pounds, while the concrete pile would carry 65,000 pounds. The greater carrying capacity of the concrete pile is, of course, due to its increased taper. This taper may be varied according to the nature of the material to be penetrated. The relative appearance of the two kinds of piles is shown in Fig. 1. A comparison of wooden and concrete piles for wall foundation work is shown in Fig. 2, the number of concrete piles being one-half that of the wood, while the bearing surface is nearly 39 per cent. greater. The Bryson building, Chicago, costing $250,000, has concrete piles under its foundation after the manner shown in this illustration. The system used at the works of the J. I. Case Plow Works, Racine, Wis., is shown in Fig. 3. The ground on which this plant stands is of such a character that some system of piling was necessary. The water level is so far below the level of the ground that the driving of timber piling below the water line would have required an expensive filling of concrete from the piles to the surface.

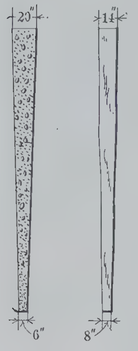


Fig. 1.

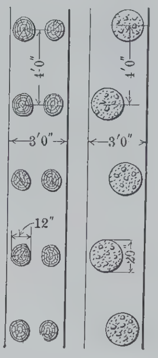


Fig. 2.

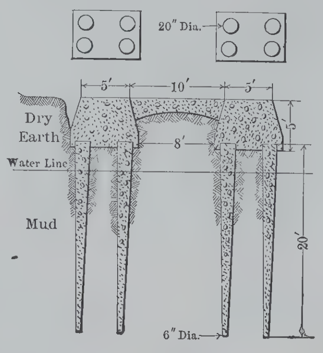


Fig 3.

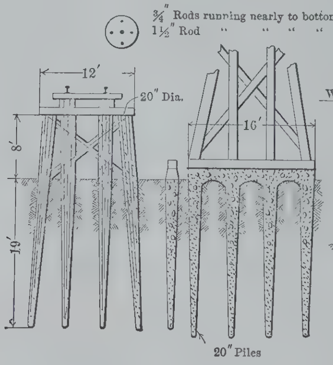
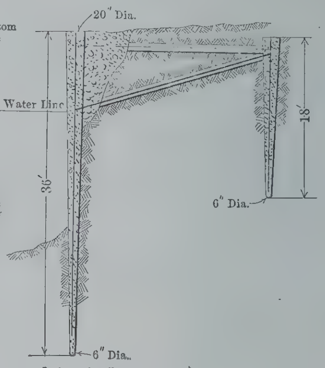


Fig. 4.



Industrial Press, N.Y.

Fig. 5.

It is possible to use the concrete piles for trestle work, two methods being illustrated by Fig. 4. Where the pile comes above the surface it is stiffened and strengthened by steel rods imbedded within its length from top to bottom, as shown. They may also be sway-braced by steel rods and concrete. For docks it would seem that the concrete system should be especially desirable because of the permanency it insures. They are naturally more expensive than those of timber, but the latter can only be regarded as temporary. The illustration, Fig. 5, shows the construction, with concrete backing and anchorage. The advantages of the concrete pile may be summarized as follows:

It is practically everlasting, the surrounding conditions of soil or water not affecting it. The water line in the soil may be entirely disregarded, unlike timber piles, which must be cut off below this line to prevent decay. On the wooden piling solid foundations of considerable depth must be built in order to reach the surface, involving a large amount of excavation. Use of concrete piles avoids this. The concrete pile may be made with practically any desired taper, an increase of which is held to give increased supporting power. Timber exposed to sea water must be renewed periodically as a result of the ravages of the teredo. Relief may be obtained from this difficulty through the use of the concrete pile.

THE PRODUCTION OF STEEL IN THE UNITED STATES.

Cassier's Magazine, July, 1902, p. 376.

Theodore W. Robinson, first vice-president of the Illinois Steel Company, says that in 1870 the great Menominee, Gogebic, Vermilion and Mesaba iron ore ranges in the United States, were unknown wilderness. The annual production of all grades of steel was under 70,000 tons, an amount less than the monthly output of a modern Bessemer plant. Thirty years have sufficed to increase the annual production to 10,500,000 tons. In 1870 the principal product of the rolling mills was iron rails; now iron rails are a thing of the past and the price of steel rails has dropped from $166 to $28 a ton. Machinery has made startling changes in the iron and steel industries. Where formerly 1,200 tons per month was a large product for a blast furnace, it is now possible to produce 19,000 tons of pig-iron per month from a single stack. This means that 1,800 tons of raw material must be handled every twenty-four hours. In the steel mill machinery has replaced manual labor. Where formerly a small army of employees was necessary, a few skilled mechanics and engineers suffice. The mill was a teeming hive of sweating humanity pulling and hauling, raising and shoving masses of white-hot metal from roll to roll, from pass to pass, with clumsy hooks and tongs by force of brawn and muscle. The tendency was in the direction of the development of brute strength rather than higher intelligence; now the conditions are reversed. The introduction of automatic machinery brought about a new order of things. The rolling mill machinery that has replaced the former crude appliances, is a monument to mechanical ingenuity and engineering skill. Twenty-seven hundred tons of steel rails—enough to lay twenty-one miles of track—have been produced in a single mill. This performance was all the more remarkable as the specifications allowed a sectional variation of not more than one sixty-fourth inch. Regarding wages: In 1876 the average production of a rod mill was twenty tons per twenty-four hours and the average daily wages was $3.66; it is now no uncommon occurrence for a rod mill to roll 400 tons a day. The present average wage is $4.71 per day.

ELECTRIC THIRD RAIL SYSTEM OF THE B. & O. R. R.

Book of the Royal Blue, July, 1902.

August 4, 1902, was the seventh anniversary of the first operation of electrical railway trains on the Baltimore & Ohio R.R. in the Baltimore tunnel and on the Belt Line. This application of electricity to the hauling of heavy railway trains was the pioneer installation of its kind, so its operation has always been regarded with general interest. The first electric locomotives used were built by the General Electric Company. They weighed about 96 tons and had a hauling capacity of 1,000 tons up a 60-foot grade at a speed of ten miles an hour. Current was conducted to them by means of overhead conductors. These were made up of two Z-bars held together by a cover plate, making a sort of box-like construction. The conducting shoe of the locomotive was made to slide in the overhead slot thus formed. The conductors were supported by iron columns standing on each side of the tracks, and by cables. The columns were connected across the tracks by metal framework and lengthways

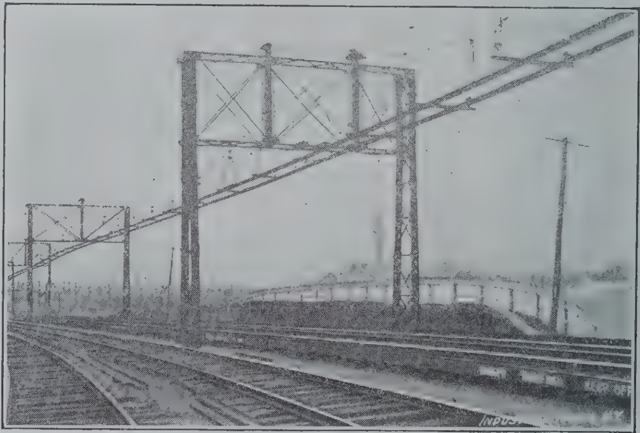


Fig. 1. The Old and New Way, showing the Overhead Framework and the Third Rail. The Overhead Framework has since been Removed.

of the tracks by the cables hung in catenaries. The sections of conductor between the columns were suspended from the cables in about the same manner as a suspension bridge. This system was used until last March, when it was abandoned for the third-rail system, in which the third-rail is placed outside the tracks.

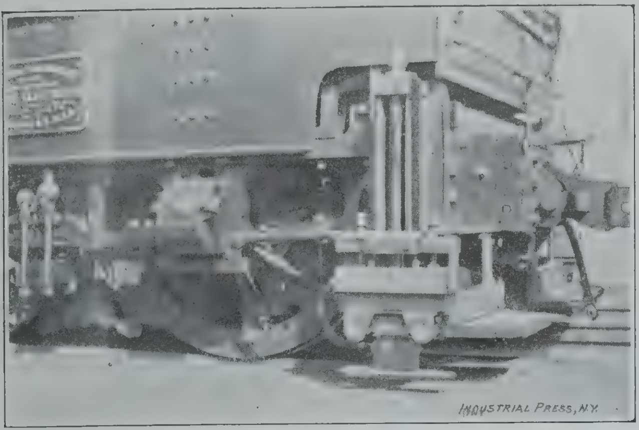


Fig. 2. Conducting Shoe of Electric Locomotive; one is attached to each of the Four Corners.

The third rail is placed along the outside of the east and west bound tracks. It is supported by means of guard and insulator stands, which are attached to ties at centers of approximately twelve feet. These guard and insulator stands form a support for planks placed on either side of the rail, acting as a guard to prevent employes coming in contact with it. Through the two passenger stations, Camden and Mount Royal, which are about a mile and one-half apart and at the ends of the tunnel passing under the city, it was necessary to modify this construction in such a way as to prevent all possibility of the traveling public coming in contact with the charged conductor. To accomplish this, there were several precautions taken. The third rail was laid through the station at the standard height and on the insulators in the regular way, but it was completely covered over, the conducting shoe being allowed to make a contact through a wooden covered slot supported by iron members from the under side. In addition to this, the rail was cut into sections, each of which was insulated from the one next adjoining, and controlled by the Murphy safety switch in such a way that the current would be on a section only when the locomotive was passing over that particular section. In the same way, the third rail adjacent to crossings of foreign roads, special work and in the yard was cut up in sections and protected by safety switches.

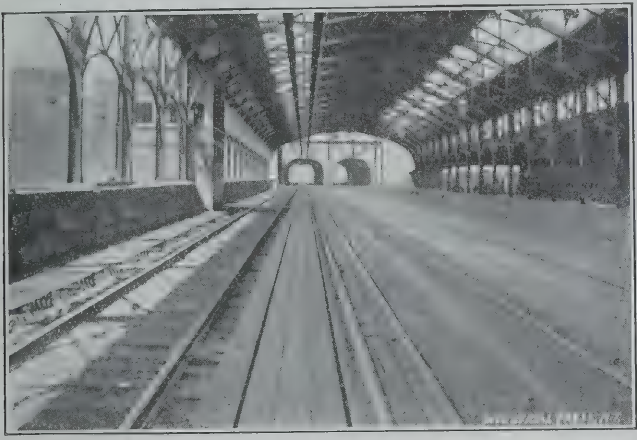


Fig. 3. View of Tracks in Mount Royal Station, showing Conductor Slots, which are the Black Lines in the Center.

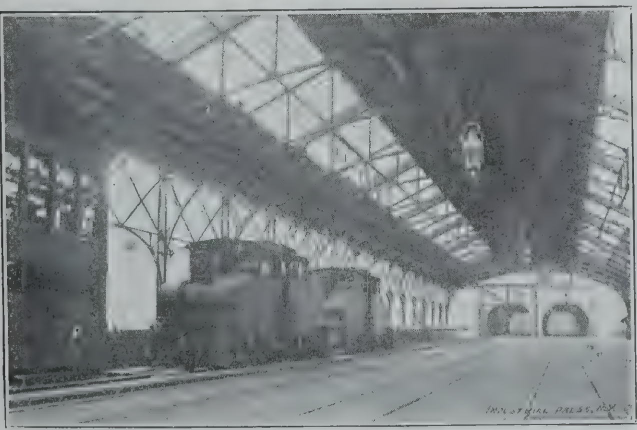


Fig. 4. Electric Locomotives in Mount Royal Station, Baltimore. Switch Towers at Left Foreground.

The advantages of the third-rail system are that it is cheaper than the overhead construction, costing only about one-fourth as much; it is more easily adapted to changes of the tracks that may have to be made from time to time, and is more easily repaired. The element of danger to employes is the one drawback, but this is not considered serious. It is held that the public have no business to be on the right of way except at stations and crossings, and at these points ample protection is provided. Each locomotive has four conducting shoes to take current from the rail, one at each corner. The matter of designing a shoe that will pick up at least 2,500 amperes without excessive sparking was a difficult one in itself. Each shoe is flexibly connected to the locomotive so that it can at all times conform to all inequalities and irregularities of the tracks and third rail. It has eight distinct movements within limits: Up and down, out and in, rocking laterally, and tilting in either direction to take inclines.

The number of freight trains hauled by electricity on this line has practically doubled in seven years, taking the figures for the months of September, 1895 and May, 1902. In the first month mentioned, 333 freight trains were hauled, and in the month of May, 1902, 641 freight trains. Two new locomotives of heavier design (150 tons) will be put on next spring having 50 per cent more hauling power than those now in use.

FRICTION OF WATER IN PIPES.

The Engineer, July 1, 1902, p. 470.

In hot water heating of buildings the circulation of water through the pipes and radiators depends (usually) on the difference in weight of the water before it enters the radiators and after, when it has lost some of its heat and consequently has a somewhat higher specific gravity. Since this is the motive force of circulation, and as circulation is vitally necessary for the success of the heating system, the calculation of pipe sizes for a hot-water heating system should be carefully done. For economical reasons the pipe sizes for the risers and re-

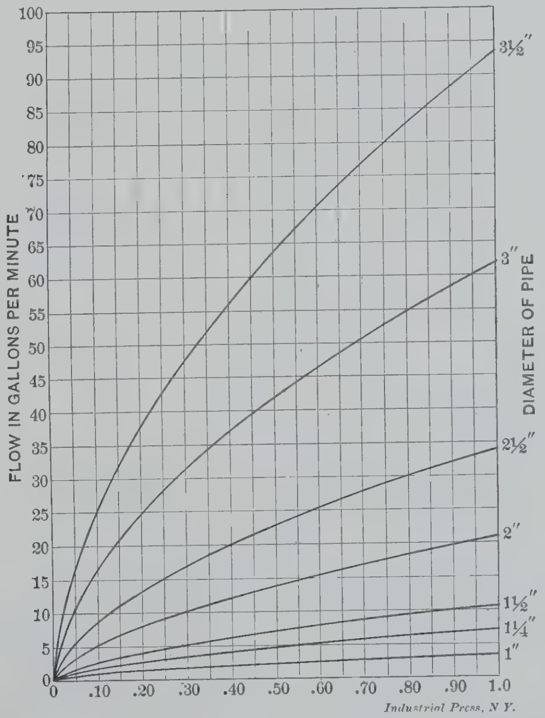
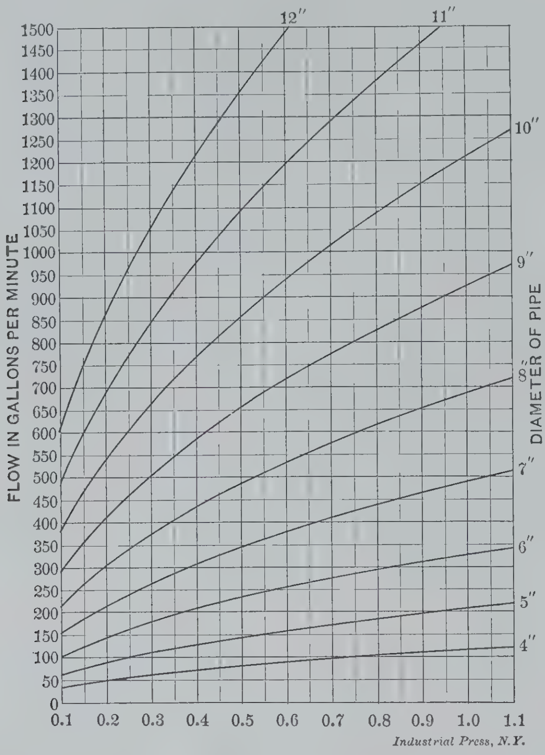


Fig. 1. Friction Loss in "Feet Head" per 100 feet in Length of Pipe.

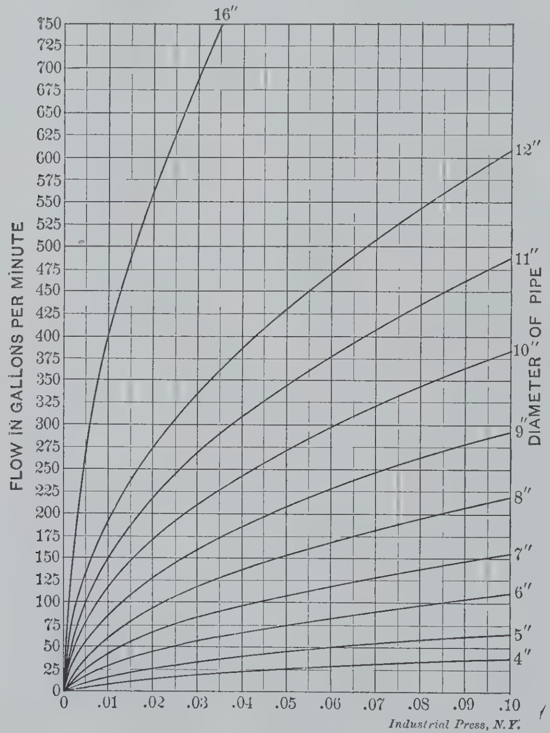
turns must be kept as small as possible and still have the circulation equal to the demands of the system.

A column of water 1 inch square and 12 inches high gains .000154 pound in density for each degree it is cooled between the limits of temperature of ordinary hot-water heating, or, say, 212 and 150 degrees F. In pipe size calculations this is usually expressed in "feet head" instead of pounds. The weight of a column of water 1 inch square and 12 inches high at a temperature of 170 degrees is .422 pound. One foot divided by .422 equals 2.37 feet head necessary to produce a pressure of 1 pound. So a pressure of .000154 pound multiplied by 2.37, which equals .000365, transforms it into "feet head." The elevation of a radiator is usually measured from the center of the water space in the boiler to the top of the radiator. If the elevation of a radiator above the boiler is 40 feet the temperature in the flow pipe is 180 degrees and that in the return pipe is 160 degrees, what is the head for producing circulation? 180 — 160 = 20 degrees difference in temperature; therefore 20 × 40 × .000365 = .292 feet.



Industrial Press, N.Y.

Fig. 2. Friction Loss in "Feet Head" per 100 feet in Length of Pipe.



Industrial Press, N.Y.

Fig. 3. Friction Loss in "Feet Head" per 100 feet in Length of Pipe.

In the case of long pipes and low heads only the friction of the pipe need be considered in calculating the flow. With constant velocity and diameter of pipe the friction head varies directly with the length of the pipe, so that having been calculated the friction head for one length of pipe the others may be found directly by proportion. The friction head, in pipes having a smooth interior similar to lead and brass, and from ½ inch to 3½ inches in diameter, may be computed by the following formula:

$$H = \left(.0126 + \frac{.0315 - d\,.06}{\sqrt{2}}\right)\frac{l}{d}\,\frac{v^2}{2g}$$

in which

H=the loss of head due to friction, in feet.

d = internal diameter of pipe in feet.

v = the velocity of flow in feet per second.

l = the length of pipe in feet.

$2g = 64.32$.

For pipes 4 inches in diameter and over, and having interior surfaces similar to new cast iron, the formula should be changed to

$$H = \left(.019892 + \frac{.00166573}{d}\right)\frac{l}{d}\,\frac{v^2}{2\,g}$$

Diagrams have been made from which the friction head can be determined without calculation. The curves in the three diagrams were laid out by means of Weston's formula, and give the flow in gallons per minute for different size pipes with low friction heads as met in hot-water systems. Suppose that the radiator mentioned having 40 feet elevation above the boiler required 40 gallons a minute in order to supply the necessary radiation. What pipe size will be required for the riser and return? Since the elevation of the radiator is 40 feet, assume 80 feet of pipe through which the water must pass. Since the diagram is laid out for lengths of 100 feet we may conveniently take the flow to be such a proportion as our pipe length is of 100 feet or 80-100 equals 4-5. 4-5 of 40 gallons equals 32. Since the available head for flow is .292 pound we follow up the ordinate marked .30 in the diagram, Fig. 1 (that one being near enough for the purpose of illustration), until the horizontal line corresponding to 32 gallons is reached. At about this point the curve for 3-inch pipe intersects, showing that this size pipe would be necessary for the required flow when no allowance is made for elbows and valves. An elbow is considered to oppose as much resistance as a length of pipe equal to 60 diameters and a return bend, 120 diameters. A globe valve is regarded to have about the same resistance as an elbow.

* * *

A REVEREND INVENTOR.

A Western bishop, who has invented an improved cutting box and a folding saw-buck, has now turned his attention to railroad matters and devised a spark arrester that is simplicity itself. The smoke stack of the locomotive is curved backward and discharges into a sheet iron pipe attached to the tops of the cars. The section of pipe on each car is made funnel-shaped at the front end, which enables the rear end of the section of the car ahead to enter and give the necessary room for flexibility at curves. The funnels also cause cold air to mix with the smoke and sparks from the locomotive and insure that all sparks will be cold and lifeless by the time they are discharged from the rear end of the train. This beautiful arrangement also insures that the passengers will not hereafter be troubled by dust and cinders from the engine, so that it will make no difference what kind of coal is burned so far as it affects their comfort. Now a little study of the different devices that have been invented and patented for this purpose, and which can be seen in the *Official Gazette* of the United States Patent Office, kept on file in almost every public library, would have saved the reverend gentleman considerable trouble and expense, and probably some distress of mind. If Andrew Carnegie's free public libraries, being so liberally distributed throughout the land, can be made of sufficient educational force to discourage such freak inventions that result alone would be worth a good deal to a certain class of misguided people, but it is doubtful if anything could discourage some of them.

LETTERS UPON PRACTICAL SUBJECTS.

AXLES FOR INDUSTRIAL CARS.

Editor MACHINERY:

At the machine company where I am located at present we have occasion to turn quite a large number of axles for industrial cars. These are made from 2-inch square steel about 65 inches long and have their ends turned to 1 15-16 inches diameter for a distance of eight inches. The bodies of the axles are left square. When wanted we usually had to get them out in a hurry and the work required nearly all of our medium size lathes, each lathe averaging about eight axles per day. Fig. 1 shows an old timer of a lathe rebuilt, on which we are turning out forty axles per day. While we do not think the machine is a beauty in design, it is not far behind in its output.

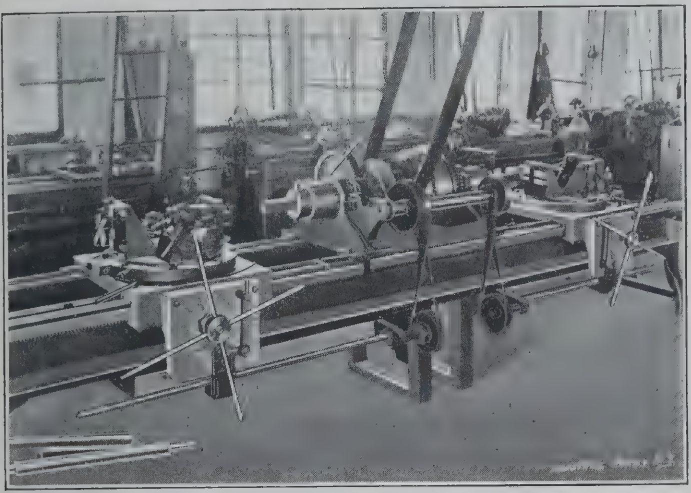


Fig. 1. Old Lathe Rebuilt for Turning Axles.

It consists of a strongly made headstock carrying a hollow spindle large enough for the material to pass through freely. On each end of the spindle is a cast-iron chuck with square hole and four setscrews for a slight adjustment of the work. The plate on which the turret tools are fastened has equally spaced holes in which the locking pin locates each tool in its correct position. Around the plate is a clamping ring *B*, Fig. 2, which is tightened by the cam lever *C*, and holds the plate-carrying tools in a rigid manner.

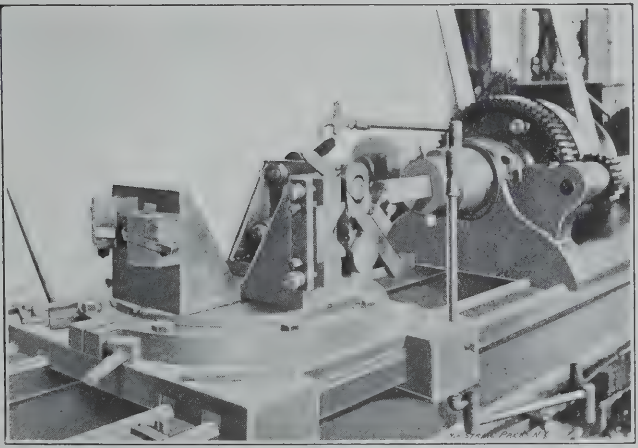


Fig. 2. Turret and Tools Equipment.

For turning axles we have only three operations. The tool *D* is for pointing the end; the other two tools are similar to those on a Jones & Lamson turret lathe—one being used to rough out, the other to finish. The cut shows the construction quite plainly, and also indicates that plenty of cast iron and steel has been used to make it stand the abuse that it gets in coarse feeds, and the shock from turning off corners of square stock.

While not in use as an axle lathe, we use one end of the lathe to do larger work than our Jones & Lamson turret can handle, having a tool holder in which the automatic die for threading from the other turret lathes interchange. We have also fitted a regular four-jawed chuck to one end of the spindle, so that the possibilities of the machine have been multiplied for quite a number of jobs. A. A. AVERY.

Warren, Pa.

THEORY AND PRACTICE.

Editor MACHINERY:

In W.'s article on page 361 he asks for an explanation of the paradox concerning scientific laws and actual practice in the matter of frictional resistance. First permit me to quote the stock phrase, "Theory and practice are never at variance," and then I will attempt to show that it is true in this case.

All surfaces, however smooth or polished they may be, have minute elevations and depressions in them, owing to the porosity, to a greater or less degree, of all matter. Consequently, when two surfaces are in contact the elevations of one drop into the hollow of the other and a resistance called friction is offered to an attempt to move one body over the other in the plane of their contact. This friction consists in the resistance offered by the elevations in the material to breaking off or bending over and in the weight or perpendicularly applied pressure that must be overcome in order that the body may rise sufficiently to allow the elevations to slip up out of one hollow and down into the next, etc. From this it is evident that friction is dependent upon the kind of material, upon the condition of the surfaces as to smoothness, and upon the weight or pressure perpendicularly applied. That is, the harder the substance the more difficult it will be to break off the elevations and fill up the hollows; the rougher the surface the higher will be the elevations and the deeper will be the depressions; the greater the weight or perpendicularly applied pressure the greater must be the force exerted in order to raise the body so that the elevations may pass from depression to depression.

Friction is independent of the area of the surfaces in contact. Provided the weight was the same there would be no more friction or resistance to the motion of a large planer bed upon its ways than there would be to the motion of a small planer bed upon its correspondingly small ways. I hear you say that the larger the ways the greater would be the number of elevations and hollows in the surfaces of the rubbing parts. All of which is true, but the weight is distributed over a larger area and is proportionately less upon each particular roughness of the surface; consequently the friction of each particular particle is less with a surface of large area than with a surface of small area where the pressure upon each particle is greater. The aggregate friction is the same whether you have a large number of small frictions or a small number of large frictions.

When, however, the pressure becomes so great that the material is unable to withstand it and crushes down, a cutting action is produced when an attempt is made to slide the surface of one body over the other in the plane of their contact. Take a flat plate of lead and place upon it a weight, with a flat side in contact with the plate, so heavy that it sinks slightly into the lead plate. Now attempt to slide the weight along on it and a shaving of lead curls up in front of the weight. That is not mere sliding friction resisting the motion of the weight—that is a shearing or cutting action, *i. e.*, an intense friction increasing more rapidly than the pressure. When the surfaces are large enough to stand up under the load without crushing and cutting then the friction is the same, regardless of the area of the surfaces.

It was originally supposed that friction was also independent of velocity, but the later experiments of Bochet show that after a speed of approximately one foot per second is exceeded it decreases gradually as the velocity increases.

It will take more force to overcome the friction of quiescence than it will to keep a body in motion. This is especially noticeable where one body is sufficiently heavy to slightly indent the other when at rest, but this excess of friction may be instantly overcome by a slight jar.

Thus far I have only followed in the footsteps of X and stated the general laws of friction. Much more might be said on this interesting subject but it does not come within the scope of this article. For the benefit of any who may desire to go farther into this subject or obtain values of the coefficient of friction for different substances, I will refer them to: "Machinery and Millwork, by W. J. M. Rankine," pages 348-354 inclusive; "Theoretical Mechanics, by Julius Weisbach," pages 309-370 inclusive; "Nouv. Recherches expérimentales sur le frottement de glissement, par M. Bochet," in the Annales des Mines, Cinq. Serie, Tome XIX, Paris, 1861.

I will now endeavor to explain why a larger disk would have had more effect than the small one in checking the speed of rotation of the drum, and why the small shaft revolved when the live center was in the deeper hole in the end of the shaft, and remained stationary when the shaft was turned end for end.

The question in dispute between X and Y is, in reality, not one of friction at all; but, instead, one of moments. Place the one-inch disk against the end of the four-inch drum with their centers coincident and the frictional resistance is not applied at the center or axis of the drum, but at a distance from it equal to two-thirds of the radius of the disk. Perhaps if I work a few examples my meaning will be more clear. First, let us assume that the condition of surface, velocity of rubbing and pressure exerted remain constant. We will consider in all four cases: The one-inch disk with its center coincident with the axis of the drum; a four-inch disk having its center coincident with the axis of the drum; the one-inch disk with its center at a given distance from the center of the drum, and a ring with its inner and outer diameters three and four inches respectively and its center coincident with the axis of the drum.

Let P = the pressure applied perpendicularly to the disk—say ten pounds.

Let f = the coefficient of friction, *i. e.*, the ratio of the friction for a given material and condition of surface to a perpendicularly applied pressure of one pound = .5 for dry leather on a metal surface.

Let l = the leverage, or distance from the center of application of the frictional resistance to the center of the rotation.

The mechanical effort = P l f.

Let r = the radius of the disk.

In the first two cases the mechanical effort equals

$$Plf = \frac{2Prf}{3} = \frac{2 \times 10 \times r \times .5}{3} = \frac{10 \times r}{3}$$

As r in the second case is four times the length of r in the first case, the mechanical effort must necessarily be four times as great as in the first case; or, in order to obtain the same effort the pressure exerted would only need to be one-fourth as great. Thus Y was correct in thinking that the use of the larger disk would show a better design, and also in saying that "The disk would last longer." The larger disk would retard the rotation of the drum more than the small one—not because of more friction, but because of the greater effort or moment obtained on account of the greater radius of the larger disk. Moreover, it would last longer because the unit pressure and consequently wear of the larger disk would be less than that of the smaller one.

Now let us see what the result would be if we should move the smaller disk toward the circumference until its center is at a distance from the center of the drum equal to two-thirds of the radius of the larger disk. As the moment arm is the same we would have the same effort exerted and the same pressure required to produce the result obtained by using the large disk with its center coincident with the center of the drum; but, as before, the wear on the small disk would be greater on account of the greater unit pressure.

We will now consider the fourth case, of the ring and the effort exerted by it to retard the motion of the drum. Take the large disk previously spoken of and cut out the center of its face, leaving a ring bearing surface at the outside one-half inch in width.

Let r_1 = the larger radius of the ring.

Let r_2 = the smaller radius of the ring.

Then the center of application or leverage of the frictional resistance will be at

$$\frac{2}{3} \times \frac{r_1^3 - r_2^3}{r_1^2 - r_2^2} = \frac{2}{3} \times \frac{8 - 3.375}{4 - 2.25} = 1.762$$

inches from the center of the drum. As the center of application of the resistance is at a distance from the center of the drum of only .33 inches in the case of the small disk and 1.33 inches in the case of the large one, we find that we only require .187 as much pressure in the one case and .755 as much in the other by the use of the ring as we do if we use the disks and bring the center of application nearer to the center of rotation of the drum. This shows that the greater the leverage the greater will be the effort retarding the rotation. If we continue this idea the leverage of the resistance may be made so great as to entirely overcome the turning effort and we have an effectual brake holding the drum stationary after the clutch that holds it has been thrown out.

It was the same principle of moments involved in the turning or non-turning of the piece of shafting between the centers. Thus theory—when it is known—agrees with practice.

Sc. Pr.

SPACING THE TEETH FOR A RACK PATTERN.

Editor Machinery:

We have had, at various times, to make patterns of a double rack, Fig. 1, on which a gear runs alternately first on one side and then on the other, and which is used for driving the beds of printing presses. In measuring the patterns I have been surprised at their exceeding accuracy, and also at the rapidity with which they were made, and it has occurred to me that the method used in making them might be of interest to your readers.

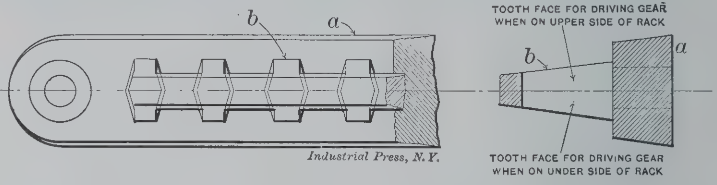

b
a
TOOTH FACE FOR DRIVING GEAR WHEN ON UPPER SIDE OF RACK
b
a
Industrial Press, N.Y.
TOOTH FACE FOR DRIVING GEAR WHEN ON UNDER SIDE OF RACK

Fig. 1.

The teeth b, Fig. 1, are made separately with a tenon which fits a corresponding mortise in a. All of this is simple enough until we get to making the mortises and spacing them accurately. The back part a is made in two parts divided on the line m, Fig. 2. The mortises are cut on a circular saw and the spacing is done as follows: First a hardwood stick q, Figs. 3 and 4, about ⅛ inch x ¾ inch, and of sufficient length for the rack, is carefully spaced to the correct pitch, the center of each tooth being cut square across with a knife and to a considerable depth. This is temporarily fastened to the top of the back a, being left square as indicated at k, Fig. 2.

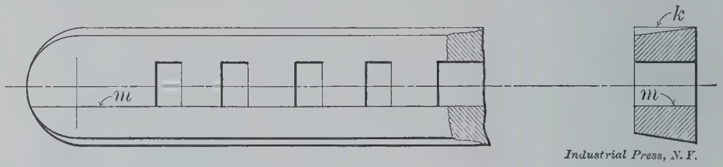


Fig. 2.

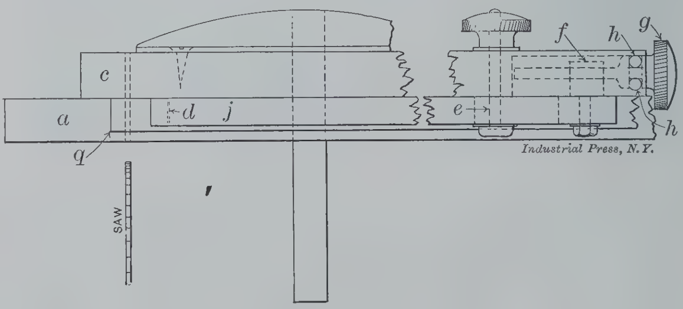


Fig. 3.

The cross-cut gage of the saw table is screwed firmly to a piece *c*, Figs. 3 and 4. A piece *j*, shaved down thin enough on the end to spring easily, is held to *c* by means of a bolt *e* in a slot in *j*, and is adjusted crossways of the saw table by means of a nut and thumb screw *f* and *g*, the end motion of the screw being checked by the pin *h*. At the left end of *c* is a thin knife edge, *d*.

To use this device the back *a* is placed against the gage *c*, and the knife edge dropped into the first notch in the spacing stick, when a saw cut is made. Then take hold of the piece *j* and spring it up while the back is moved along until the knife edge will drop into the next notch, when another saw cut is made. Proceed thus until one side of all the mortises has been sawn. Then go back to the first cut and saw the other side of the mortises in a similar way, first adjusting for the width of mortise by means of the bolt *e* and thumbscrew *g*.

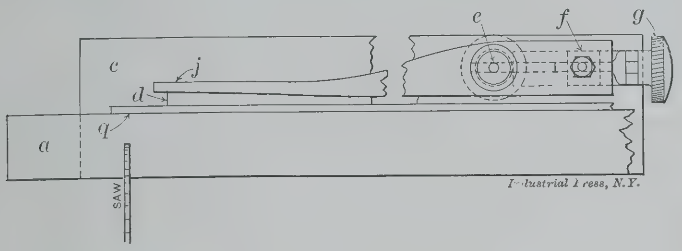


Fig. 4.

The tenons on the teeth must be a good fit in the mortises and all be alike. In driving them care must be taken to get them straight, which is not a difficult matter if the glue is properly used. The glue should be thin and used sparingly, a little good glue being much better than more, for any kind of work.

New London, Conn. **Fred S. English.**

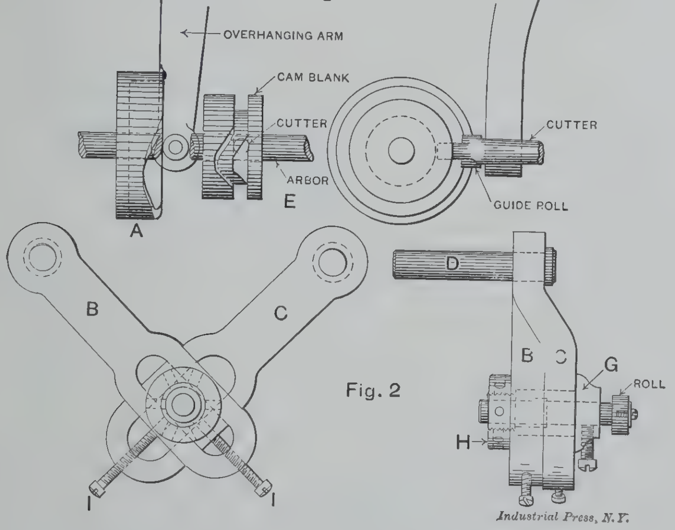
MILLING CAMS.

Editor Machinery:

The accompanying sketch and photograph show a very convenient method of milling the grooves in positive motion cams of the type shown at *E* in Fig. 1.

The guide *A* is a cup-shaped casting, the walls of which are about ¼ inch thick. Castings of these guides can be kept on hand and the grinding edge easily finished by hand for any cam required. In preparing the guide it is well to face the outer edge at the back so as to have a true surface from which to work when laying out the throws of the cam. If the circumference of the guide is divided into any desired number of divisions and the different distances measured endwise from the true edge, the cam can be easily laid out.

Fig. 1



Details of Cam Milling Fixture.

Having shaped the edge of the guide to the desired form, the guide and cam blank are put on an arbor and mounted on the index centers of a universal milling machine. The overhanging arm of the milling machine is fitted with a pin and guide roll and is set slightly to one side of the center of the spindle so as to bring the guide roll in contact with the edge of the guide. This guide roll is made long enough to allow the cutter to be fed into the cam the full depth of the grooves.

In operation the arbor with the form and blank is revolved by turning the index crank. At the same time the guide is held against the guide roll by moving the table of the machine. The cutter is fed, a little at a time, endwise into the cam blank.

I have found that a very convenient machine for doing this work is a vertical mill, or die sinking machine, provided with some means for holding the guide roll. The photograph shows a cam being cut by this method. As will be seen, the cam blank and guide are mounted on the same arbor, which is held on the index centers.

Fig. 2 shows the device which is used to hold the guide roll. It consists of two cast-iron arms, *B* and *C*, one of which, *C*, is offset to allow the end to pass under the end of *B*.

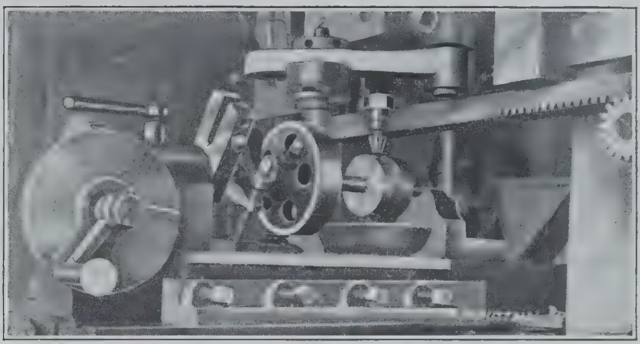


Fig. 3. Fixture Attached to a Milling Machine.

In the end of each arm is driven a pin, the projecting ends of which are fitted to the guide pin holes on each side of the spindle. Setscrews secure these pins when they are put in place. The outer ends of the arms are clamped together by the nut *H* and the bushing *G*, through which runs a pin carrying the guide roll. The setscrews *II* provide for locating and adjusting the guide roll.

I have found a two-lip mill to be the best for roughing out either steel or cast-iron cams, and it is sometimes the best for the finishing cut also.

Meriden, Conn. **James P. Hayes.**

MORE ABOUT FRICTION.

Editor Machinery:

In the August issue "Practice" discusses the reason for the deep center and shallow center and apparently proves his case. When it comes to the theory and practice of friction, however, there are some cases which keep a fellow guessing. Take modern locomotive practice and we find some peculiar features. The driving boxes carry from 18,000 to 25,000 pounds each, or in the neighborhood of 300 pounds per square inch of projected area. These boxes must have a good bearing nearly halfway round or there is trouble from heating.

The truck boxes of the same locomotive seem to be governed by a different law, but of course they are not. These carry perhaps 10,000 pounds each, but instead of having a full bearing on top of the axle there are two babbitt strips running lengthwise. These strips are usually one inch wide and spaced quite a distance apart. Take the projected area of these strips and we find it a pretty small amount, making the pressure per square inch run up pretty high. Yet these bearings run cool until the strips wear down so there is a bearing at the top of axle and box; then they heat. Why?

The tender truck boxes, on the other hand, have the regular full bearing the same as the car truck, and they run without much trouble, carrying heavy loads.

The driving box has to stand the thrust of the cylinder and requires the side bearing, while the top of the box carries the load. The truck or leading wheels have bearings almost all front and back, which takes the rolling thrust, but what carries the hood in the absence (practically) of projected area is something of a mystery.

I certainly do not believe that contact surface means friction in every case or a roller bearing would always have more friction than a ball bearing. As showing the tendency in this direction I may mention that the leading automobile builders are abandoning ball bearings in the wheels and other parts for long plain bearings.

Who has the right theory?

I. B. Rich.

MECHANICS IN THE COUNTRY.

Editor Machinery:

The firm for which I used to work once sold a second-hand threshing engine, and three or four days after, word came that the feed pump of the engine would not work, and "to send a man out at once to make it work." At this the Old Man said: "That is strange; it worked all right here when we tested the engine. We are very busy and I don't see how we can spare a man, but I will just go out myself and see what is eating those fellows anyhow."

He rode out on the train about 15 miles to a small town where a man and team were to meet him. At the station he found a man but no team. The man told him there would be a team and driver in pretty soon with a load of grain, and that they could ride out with him. After waiting some time the Old Man got nervous. He wanted to get home on the noon train. Finally he asked the man how far it was out to where they were threshing, and was told that it was just two and a half miles from the edge of the town. "Well," said the Old Man, "I can walk it if you can." So they started out. It was pretty warm weather and after walking about an hour the Old Man inquired if they were not almost there. "Do you see that little red schoolhouse on ahead there? Well, that is just half way." The schoolhouse appeared to be a mile or more ahead of them. They got to the place at noon and found most of the men at dinner.

Steam was down. The engineer and another man were putting water in the boiler. They had removed the safety valve, and were pouring the water in out of a bucket, whereupon the Old Man remarked that was a sure way to get the water into a boiler. They gave the Old Man a good "roasting" for letting a rig leave the shop when the feed pump could not be made to work, and wanted to know why he didn't send out a man who knew something about engines and pumps; Tom, the foreman, for instance.

The Old Man got a monkey wrench and started to examine the pump. The first thing he did was to open the suction valve, and under it he found a lump of coal large enough to keep the valve open all the time. He called the attention of the engineer (?) to it, but the engineer knew that was not the trouble. So the Old Man said: "Well, I will get my dinner while you get up steam, and we will see if that lump of coal was not the cause of the trouble."

On the farm were three or four crops of corn, plenty of stock and every indication of a prosperous farmer. That dinner, however, "cooked" the Old Man. They had "side meat" (Breakfast bacon) and fried eggs—fried to a crisp: biscuits as hard as hardtack and yellow with soda; dried apple pie sweetened with sorghum molasses; water-logged potatoes and coffee made from scorched wheat, with no sugar and skimmed milk. Even the women folks were mad about the engine not working and would hardly speak to the Old Man, who is generally a great favorite with the women.

But when the engineer got up steam he found that the feed pump worked all right. The crowd then got into better humor, and "guyed" the engineer a little; and the farmer hitched up his buggy and let his wife take the Old Man to town. He got home at 7.30 P. M. Had spent a whole day to take a piece of coal out of a check valve! What any schoolboy could have done in five minutes.

We once rebuilt an engine for a tile and brick factory. The front head was what is sometimes called a false head—held between the cylinder and frame, and quite a job to get at. Originally it had been ground in. The man who put the engine together in the shop had put in a paper gasket, and after the engine had run a short time complaint came to the shop that the front head was leaking. The Old Man, Josh and I went out to fix it. We went Saturday evening about 8 o'clock so as not to interfere with the work at the tile and brick factory. We had the tools necessary to do the work and some good packing to take the place of the paper, which had evidently blown out. We got the head out at about midnight; then the Old Man took a notion that he would like to have that head ground in again. We had not brought any emery, as we were not expecting to grind in the head. I asked the engineer if he had any emery or broken glass. He said: "No, but I have a piece of emery paper." "Well," said I, "bring it here, and also your fire shovel." "You can't grind in a head with emery paper," said the Old Man;; "let Josh go to the shop and get some emery." But it would have taken three or four hours to have gone to the shop and back, so I rolled up the paper and set fire to it. With the ashes we soon had a nice joint, and we got through in time for church next morning.

W. A. Bright.

Decatur, Ill.

FORMULAS FOR BEVEL GEAR BLANKS.

Editor Machinery:

It is necessary when designing to know the outside diameter of gears; both, in order to be sure of a proper amount of clearance between them and a near-by shaft or wall, and also in order to detail the blanks.

For spur gears, every hand-book gives the following or similar formulas:

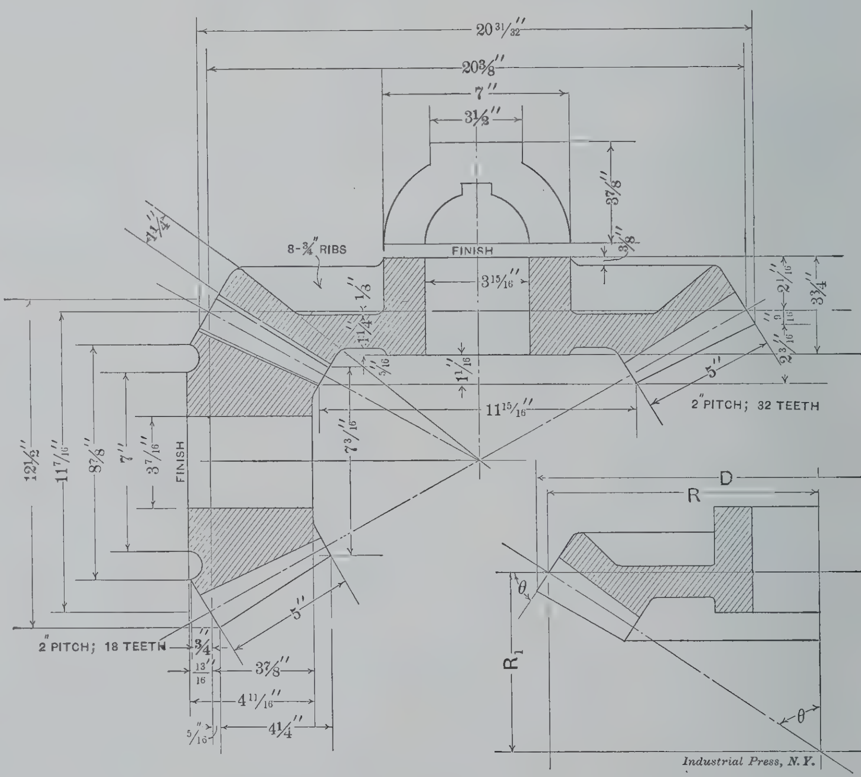


Diagram showing Method of Laying Out Bevel Gear Blanks.

Letting N = Number of teeth
P = Circular pitch
P' = Diametral pitch
d = Pitch diameter
D = Outside diameter.

We have:

$$D = d + .6\,P, \text{ and } D = d + \frac{2}{P'}$$

For a bevel gear, however, the designer, in order to know the outside diameter, must lay out the gear to full size and scale it up, as hand-books do not give any formulas for finding the desired diameter.

This is annoying as it requires the stretching of another sheet of paper and thus takes quite a little time. As a consequence the following formulas were deduced, to get rid of this difficulty and afford a quick method of arriving at the desired result:

R = One-half pitch diameter of required gear.
R_1 = One-half pitch diameter of meshing gear.
θ = Pitch angle.

Whence

$$D = d + .6\ P \text{ Cosine } \theta.$$

$$D = d + \frac{2 \text{ Cosine } \theta}{P'}$$

Or to avoid trigonometrical expressions:

$$D = d + \frac{.6\ P\ R_1}{\sqrt{R^2 + R_1^2}}$$

$$D = d + \frac{2\ R_1}{P' \sqrt{R^2 + R_1^2}}$$

The following (see the cut) is an actual case in which the above method was used, and may help to illustrate its use.

Bevel gear:

$d = 20.375$ inches.
$P = 2$ inches
$R = 10.1875$ inches
$R_1 = 5.719$ inches

$$D = 20.375 + \frac{.6 \times 2 \times 5.719}{\sqrt{103.8 + 32.7}} = 20.375 + .59 = 20\tfrac{31}{32} \text{ inches}$$

Bevel pinion:

$d = 11.4375$ inches
$P = 2$ inches
$R = 5.719$ inches
$R_1 = 10.1875$ inches

$$D = 11.4375 + \frac{.6 \times 2 \times 10\ 1875}{\sqrt{32.7 + 103.8}} = 11.4375 + 1.05 = 12\tfrac{1}{2} \text{ inches.}$$

A. E. H.

THE METRIC SYSTEM IN THE MACHINE SHOP.

Editor MACHINERY:

As the metric system of weights and measures seems to be making considerable progress in this country, it is a good plan for mechanics to become familiar with it so as to keep abreast of the times and so that if Congress should eventually pass a bill making the metric system compulsory after a given time they will be prepared for the change.

The chief objection to the metric system is really an objection to the present system of notation (the Arabic), which has 10 for a base. It is said that if the human race had been created with six fingers on each hand instead of five the base would have been twelve, and if they had neglected to count their thumbs the base would have been 8. Either of these numbers would have been better than 10, as they could easily be sub-divided a greater number of times. When France first used the metric system it was applied to divisions of the circle and time in astronomy and navigation, but this was found unpractical owing to the base being 10. The system was then confined to weights and measures, and has gradually been adopted by the various countries, and seems destined to become universal. The advocates of the metric system have probably been over-zealous in its cause, and, on the other hand, the opponents have said things against it that are not justified by fact.

But on the whole, the adoption of the metric system seems to be desirable, as our units of weight and capacity have no relation to those of measure, and other countries cannot use them in trade with us without considerable inconvenience; and we ourselves are put to a good deal of labor in reducing measures to a common denomination, which in the metric system would be very simple. For machine shop measurements, however, the English system is superior to the metric, because the foot and inch can be readily sub-divided into halves, quarters, etc.

There may be ways to obtain all of the advantages of the English system and still conform to metric units. Had the meter been made 40 inches long instead of about 39⅜ inches the metric system would probably have been adopted by English speaking people long ago, in order to have a universal standard. It is not likely, however, that the length of the meter can be changed by the countries using it. A meter contains 1,000 millimeters and 1000/40 gives 25 millimeters, which is nearly our present inch. Calling this one-fortieth meter, I would suggest a supplementary table of linear measurements for machine shop use as appended:

25 Millimeters = 1-40 Meter.
4 Fortieth Meters = 1 Decimeter.
10 Decimeters = 1 Meter.

This table would enable us to subdivide the one-fortieth meter the same as we do our inch at present. This would be of great convenience both in the drawing room and machine shop. The scales graduated into millimeters and centimeters are not so convenient for drawing purposes; one is rather too fine, corresponding to 1-32 of an inch; the next higher division, the centimeter, is 10 times as large, and in the machine shop to express fine measurements we use the fraction of the millimeter. For example: To make an allowance for a shrink fit for a shaft about 3 inches in diameter (which is about .006 inch) we would have about 8-50 of a millimeter. If the meter was divided into 40 parts our scales and micrometers could be graduated the same way as at present.

Ordinarily the decimeter need not be used, everything up to one meter being expressed in fortieth meters. This would be a better way of marking dimensions on drawings than feet and inches. Instead of using our two-foot rule the meter measure folded in four parts would make each part nearly 10 inches long, and if it was divided into 40 equal divisions and subdivisions, there would perhaps be fewer mistakes made and time would be saved in using it instead of the two-foot rule. The number 40 can be subdivided into halves, quarters and eighths, so that it is more convenient for subdivision than our dollar of 100 cents.

It is quite likely that the difficulty of changing to the metric system has been magnified. Of course there would be some extra labor in making the change. New measuring instruments would have to be procured, etc., but once the change was made we would get along in the shop the same as before. Much time would be saved in making calculations, estimates, etc., but the greatest benefit would be felt in our foreign trade, as our weights and measures would harmonize with those of the Old World, and England would be likely to soon follow us in adopting the system.

Now, supposing that in five years we were compelled to use the metric system as the only legal standard of weights and measures, what would be the result? This would give time enough so that we would be fully prepared for the change, and there ought to be very little trouble in making it. Probably before that time considerable new machinery would be designed and made to metric measurements. Machines already designed and on the market could be made from the same patterns and with the same tools as before. Standard screw threads and pipe threads would probably not be changed, as there seems to be no metric standard of screw threads used by the different countries, although one was recommended in 1898 by the International Congress for the Standardization of Screw Threads. This system was given in the supplement of MACHINERY for March, 1901. If it was required to cut metric screws the same lathes in use at present could use the same change gears by adding to the set translating gears. One inch = 127-50 of a centimeter; if we use two gears of 127 and 50 teeth for a compound it will enable the cutting of threads in terms of the centimeter instead of the inch. For example: Required to gear a lathe having a lead screw of 6 threads per inch to cut 4 threads per centimeter. 6-4 = 36-24. We could place the 36-T gear on the spindle or stud of lathe; 127-T gear as a follower or first gear on compound stud; the 50-T gear as the second driver, and the 24-T gear on the lead screw. It should be remembered that the 127-T gear should always be a follower, and the 50-T gear a driver. For some cases the compound need not be used, but a 127-T gear is always required to make an English pitch lead screw cut a metric thread, and it should be a follower or driven gear.

But if metric threads were to be the standard, metric pitch lead screws would be furnished with new lathes, and a lead screw of 4 millimeter pitch could replace the common lead screw of 6 threads per inch. Then the common change gears would answer as at present. For example: Required to cut a thread of 1¾ millimeter pitch, with a 4 millimeter pitch lead screw,

$$\frac{1\frac{3}{4}}{4} = \frac{7}{16} = \frac{28}{64},$$

and 28 on stud and 64 on screw would answer.

The changes to the metric system would, of course, first begin in the drawing room. Probably during the transition period both systems may be necessary for a while, as repairs on machines built on the English system may necessitate this. The change suggested with reference to dividing the meter into 40 parts would enable draftsmen's scales to be graduated the same way as at present. It would not be advisable to call this one-fortieth of a meter an inch, as it might lead to mistakes.

Of course the change to the metric system would necessitate new standard gages, tools, etc. Since the one-fortieth meter is slightly smaller than the inch the reamers, arbors, plug gages, etc., could be ground down to the new standard when it was not desirable to keep them for repairs on old machines.

East Providence, R. I. John T. Giddings.

A BEARING FOR OVEN-CARS AND DRAWERS.

Editor Machinery:

Sometimes it is necessary to have a bearing in a place where the varying temperature causes considerable trouble by expansion and contraction, if it is a closed bearing.

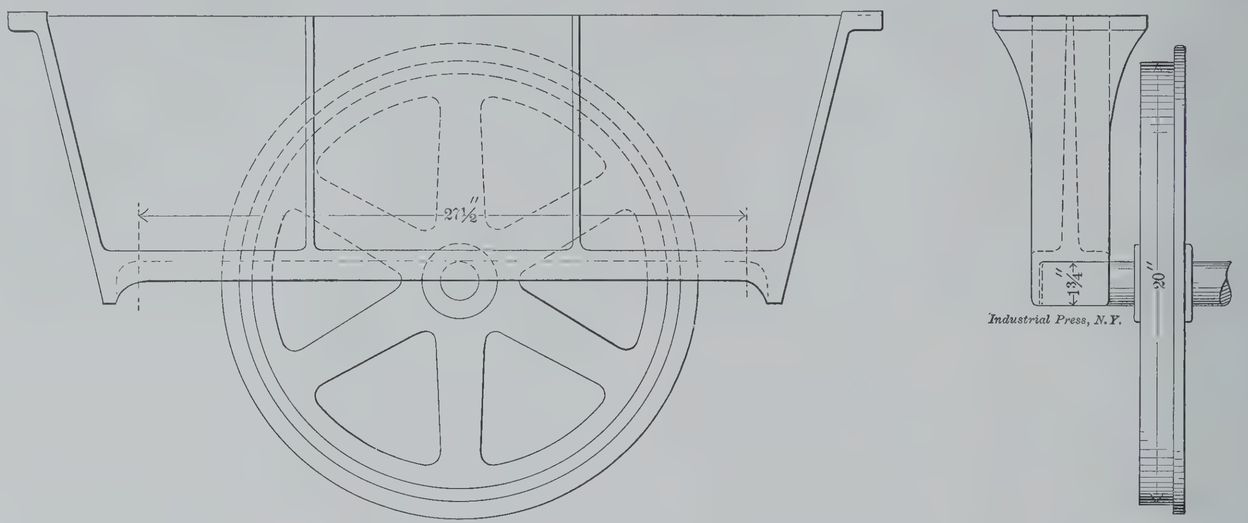


Fig. 1. Compound Wheel and Axle for Oven Cars.

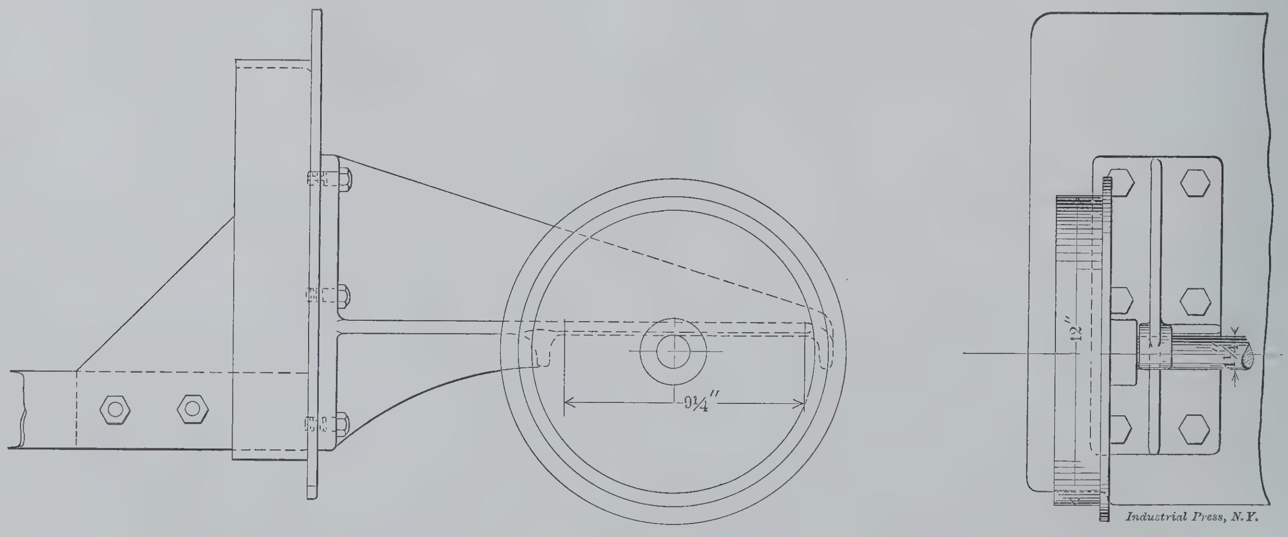


Fig. 2. Another Form of "Rolling Bearing" for use on Drawers.

We are planning a core-oven car and drawer (where the travel required is not great) to have a bearing like Fig. 1, which makes a combination for a car, and one like Fig. 2 for the back end of a drawer. The bearing surface is made long enough to allow for a little more than the distance covered by rolling the axle, which travels with the wheel, being fastened to it. A bearing 27½ inches long for a 1¾-inch axle rolling with a wheel 20 inches in diameter, will carry a car a distance of about 28 feet, and one 9¼ inches long for a 1¼-inch axle rolling with a 12-inch diameter wheel, will carry a drawer a distance of about 8 feet.

This bearing requires no oiling or cleaning. It shields the axle and if any dirt should get on the axle it falls off in revolving. The axle is kept in line by the face of the hub of the wheel for the drawer, and its (axle) end for the car, as can be seen by the sketches.

Taken altogether it makes a very practical bearing for this purpose. Both car and drawer move very easily, cost but little to fit up, do not need attention and are not affected by heat. Edwin C. Thurston.

Providence, R. I.

METHODS ADOPTED IN THE MANAGING OF A MACHINE SHOP.

Editor Machinery:

Having had charge of a shop where a great many duties were "up to me," I decided to relieve my mind as much as possible from unnecessary worry. With this point in view I took a large book about 8 inches by 14 inches with about 300 pages, and subdivided it as I saw fit. For instance, there were jobs continually coming up which were in no especial hurry, these I would jot down in the note book under the proper heading. If it was a job for machinists it would be put down under this heading; if for the office or blacksmith or patternmaker it would be noted in its proper place. Divisions were made in the book for every class of work throughout the shop. Whenever a man ran out of a job unexpectedly on my part I had but to refer to the book and start him off immediately. I made small cardboard pasters and marked them to correspond with the subdivisions in the book thus: "Machine Shop," "Office," etc., and pasted them where they belonged, with the name projecting about ¾ inch. This made it possible to turn right to the place desired without loss of time. The note book proved to be worth its "weight in gold." Each time a job was given to a man from the book a lead pencil line through the note showed it was "a dead one."

It was very necessary for me to refer to the material order books quite often. Finding this was very annoying and took a great deal of valuable time, owing to the fact the books used were ordinary duplicate order books, each order having its own number, I instructed the clerk to do as follows: Keep a record of each order on the front inside cover of the book as the orders were made out and when the book was finished transfer names and order numbers to inside back cover of book, but in a classified form, that is, alphabetically. This was a very easy matter when the book was completed. For instance, the order book ran from order No. 450 to No. 525, and the first order in the book was to Blank & Co., then it would be immediately jotted down in the front of the book. Say the next order was See & Bro., followed again by Blank & Co., etc. Then the columns would appear thus:

Blank & Co.,	450—452—456—
See & Bro.,	451—454—
Angel, A.,	453—
Doolittle & Co.,	455—

Then when, as previously stated, the list was classified and transferred to the back of the book, the above would appear in this manner:

Angel, A.,	453—
Blank & Co.,	450—452—456—
Doolittle & Co.,	455—
See & Bro.,	451—454—

From the foregoing it can be readily seen that with very little work it is possible to keep the order books in such shape that any order can be located at once at any "stage of the game." Pasters on the outside of books show the order numbers and dates thus:

Jan 1, '02. Feb. 4, '02.
450 — 525

Chicago, Ill. ROBT. A. LACHMANN.

LACING BELTS.

Editor MACHINERY:

Figs. 1 and 2 show a way of lacing or sewing a belt, which is not new but which has some good features that are often overlooked. I have found that a feed belt for a lathe or drill-press joined in this way lasts longer than any other style I have ever tried.

In making a splice of this kind care should be taken in laying out the holes to space them exactly the same distance apart and this distance should be the amount that will be generally cut off when the belt is taken up; or on a long belt the distance may be made half of this amount, and when the belt needs to be taken up, cut off one or two rows of holes as the case may be and punch new holes further back to match the other half. This kind of lacing is to be recommended for any place where a belt is kept very tight and gives trouble from tearing out the holes and breaking laces when laced in the ordinary way.

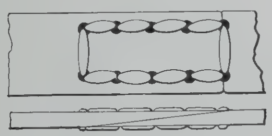
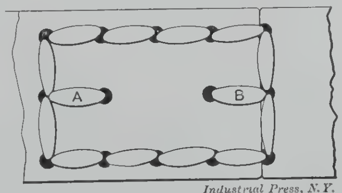


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

The holes are made much smaller and a very small lace used, and is sewed together the same as a harnessmaker sews a piece of work, i. e., by drawing both ends of lace through the same hole at same time from opposite sides. The larger belt shown in Fig. 2 is done in the same way, except that the loops at *A* and *B* are used to keep the ends of belt down in place and are made with one end of the lace only. When this point is reached it is best, if there is any difference, to use the longest end of lace to make this loop.

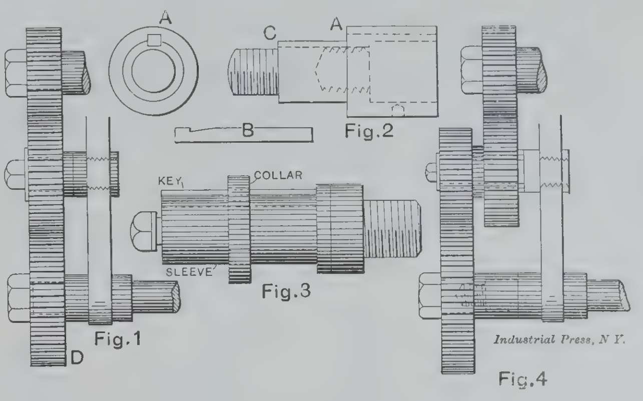
Watervliet, N. Y. M. H. BALL.

A COMPOUND GEARING ARRANGEMENT.

Editor MACHINERY:

Having a lathe which was single geared and desiring to increase its thread-cutting capacity, I arranged it for compound gearing, as shown in the accompanying sketches.

Fig. 1 shows the original gearing on the lathe, with which I could cut from three to 48 threads per inch. I removed the key from the end of the lead screw and in place of the gear *D*, shown in Fig. 1, I screwed on the extension shown in Fig. 2. A keyway was cut in this extension, so that the long key *B* extended from the end of the shoulder at *C* through *A* and into the keyway in the end of the lead screw. It thus locked the extension onto the lead screw and also provided a key for the gear *D*. The notch in the key is to facilitate its removal.



Industrial Press, N.Y.

Method for Compounding a Single-Geared Lathe.

In the place of the original intermediate stud I substituted the stud shown in Fig. 3. On this stud the gears were separated by the collar, while a key, running the entire length of the sleeve, made the gears run together.

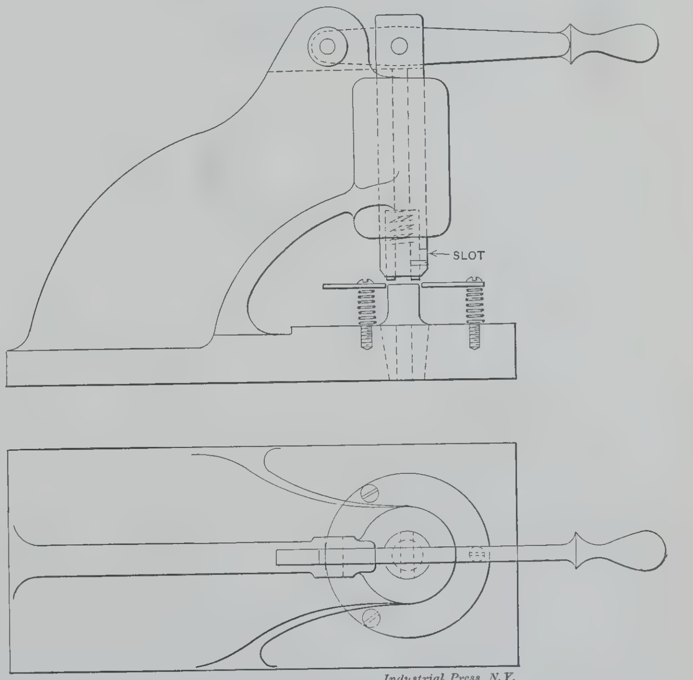
The complete arrangement is shown in Fig. 4. By making this alteration I am now able to cut from 1 to 144 threads per inch.

Meriden, Conn. JAMES P. HAYES.

PUNCH PRESS AND DIE.

Editor MACHINERY:

Accompanying this is a sketch of a small punch press and die for cutting washers from any kind of soft material. By the peculiar construction of the combination die a complete washer is cut at each stroke of the press. It also has the additional advantage of a quick and easy interchange of the various sizes of dies in the same press.



Industrial Press, N.Y.

Small Press for Punching Washers.

After the casting has been bored and reamed the taper hole in the base should be line-reamed with a reamer whose shank is a snug fit in the long ¾-inch hole. This will insure the absolute alignment of all punches and dies, without the necessity of clamping the die to the press. To obtain the best results both the punch and die should be ground all over; but some may think this an unnecessary refinement. On thick material, however, the hole in the die should be given a little draft to allow the punchings to drop through. It should not be excessive, though, as this will increase the size of the hole at each successive grinding.

I have obtained the best results on mica and fiber by leaving the die almost glass-hard. Because of the numerous small parts such as springs, screws, etc., it might be inferred that there is much repairing connected with the successful operation of the press; but I have found that this may be avoided by a little care in construction. The stock to be used need not be any particular size or shape and on small washers good results have been obtained by using scrap.

New York. H. J. Bachmann.

Fig. 1

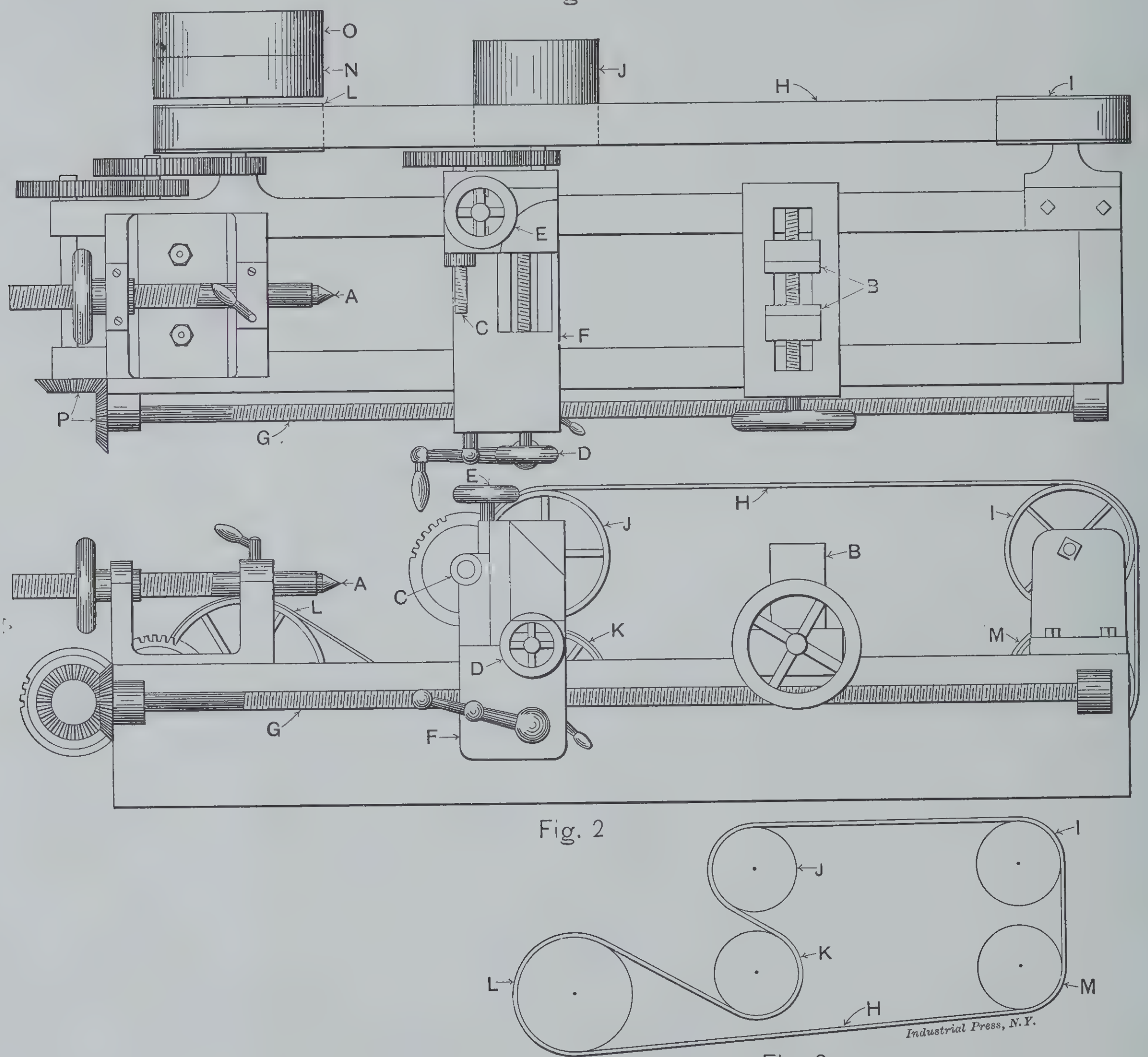


Fig. 3

Splining Machine made from an Old Lathe.

A HOME-MADE SPLINER.

Editor Machinery:

Fig. 1 shows the plan and Fig. 2 the elevation of a very serviceable splining machine which was made from an old lathe.

One end of the shaft to be splined is supported by the center *A*, while the other end is held in the chuck *B*. The keyway is cut by a milling cutter carried on the spindle *C*. Handles *D* and *E* with their feed screws provide for the adjustment of the cutter both centrally and vertically. The carriage *F* carrying the cutting mechanism is fed along the bed longitudinally, by the lead screw *G*, driven by the bevel gears *P*.

The machine is operated by a belt running on the tight and loose pulleys *N* and *O*, while the cutter is driven by the belt *H*. In order to maintain a constant tension in this belt, while the carriage travels from one end of the bed to the other, the pulleys are arranged as shown in the diagram, Fig. 3. As will be seen in the plan, the faces of the pulleys *J* and *K* are made of extra width so as to allow a liberal cross adjustment of the driving mechanism on the carriage.

Connersville, Ind. E. M. Burgess.

HOW A LONG JOB WAS DONE ON AN OLD PLANER.

Editor Machinery:

About ten years ago I had the pleasure (?) of occasionally using an old planer, one of the kind with but one belt and a return motion through gears. During the cutting stroke power was transmitted from the pulley to the table-rack through a train of eleven gears. The best of the bearings were worn not less than 1-16 inch loose and all the teeth (that were left) were worn to a knife edge, so there was quite a period of rest at the end of each stroke to take up the lost motion in the gears and bearings, and the motion of the table that followed was not unlike that of a tin can tied to a dog's tail.

The table was of the thin, flexible kind and had a piece three feet long spliced on at both ends, adding more to the length than to its stiffness, and often when I see a rainbow it reminds me of that planer table at the end of a long stroke.

One day an unusually long piece of work came in. It was so long indeed that I had to remove part of the scrap-heap to give the table room to travel. I got the work bolted on all right, but then my troubles commenced. The table, when near the end of its stroke, hung down badly and was so nearly overbalanced that the rack raised out of mesh with the bull-wheel. I hardly knew what to do; the job was not very particular, but with the table getting one end down and the other up in the air no job at all could be done. I wanted to get a pulley block over each end of the table and have ropes with weights to counterbalance the ends of the table when traveling in air, but nothing suitable for this arrangement could be found around the shop, so I had to resort to other means.

I found a piece of 1-inch x 3-inch iron and had the blacksmith give it a quarter twist. A stout pin was put through it near the bottom end and two turned cast-iron rollers were mounted on the pin, one on each side of the piece. The piece was bolted to the cross-rail, just alongside of the head. Then by screwing these rollers down tightly against the table by means of the cross-rail screws I succeeded in holding the table down on the ways and the rack in mesh with the bull-wheel until a fairly good job was done.

One good feature about this old planer, or at least one that helped some in this case, was its flexibility. The work was such that I could not keep the chips away from the rollers that held the table down, and when a handful would fall right in front of these I expected a smashup, but it was fun to see that cross-rail accommodate itself to the circumstances and allow the rollers to climb over the chips in fine shape.

There are still many of these old planers scattered through the country, and some of them still capable of producing good work when skillfully handled. But what *can* be done on a machine is not a measure of its usefulness in the shop; good work can also be done and has been done with chisel and file, but the time element is too important a factor to be ignored, and if these old-timers were placed in direct competition with modern heavy, stiff, quick-acting planers it would be an odd kind of a job indeed on which the modern tool would not prove a better investment than those made shortly after Noah's time.

The firm who owned the old planer mentioned above failed, as many firms with such equipments do.

In the August issue of MACHINERY Mr. J. T. Giddings advocates the use of formulas for finding speeds of pulleys and gears. I don't know how it may be with others, but I rarely resort to formulas for such simple calculations. I think Mr. Giddings would find that all these can be solved on the slide-rule in less time than it takes to solve by a formula.

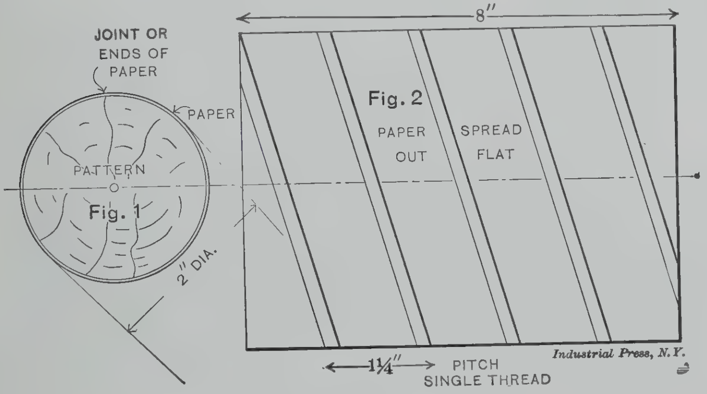
Grand Rapids, Mich. CORNEIL RIDDERHOF.

LAYING OUT A WORM GEAR PATTERN.

Editor MACHINERY:

A few days ago I was asked to make a small worm conveyor pattern, 2 inches in diameter, ¼ inch pitch and 8 inches long. I am sure that some of your readers will remark on reading this: "That's old; every patternmaker knows how to make a worm gear." Twenty years' experience and close observation have proved to me, however, that not one-half know how to *lay out* one, much less to make one. I will simply state my method of tracing the lines on the turned pattern. I have traced these lines with a flexible flat spring, also with paper cut to the pitch angle and by other methods in common use, but a better method in my estimation is the following: After turning the pattern to the required diameter, as indicated in Fig. 1, roll a piece of thin paper on the circumference. Now remove and pitch, and draw lines as in Fig. 2, then *glue to the pattern.* This gluing to the pattern is the "kink" that brings success.

"GLUE."



Laying Out Pattern for a Worm.

DEVICE FOR CUTTING OIL GROOVES.

Editor MACHINERY:

The accompanying sketches show a device, which I have used for cutting blind oil grooves in bearings, that may be of interest to MACHINERY readers.

Fig. 1 shows the bearing for which this device was designed, but it can easily be adapted to any style of bearing or used for grooving the hubs of loose pulleys.

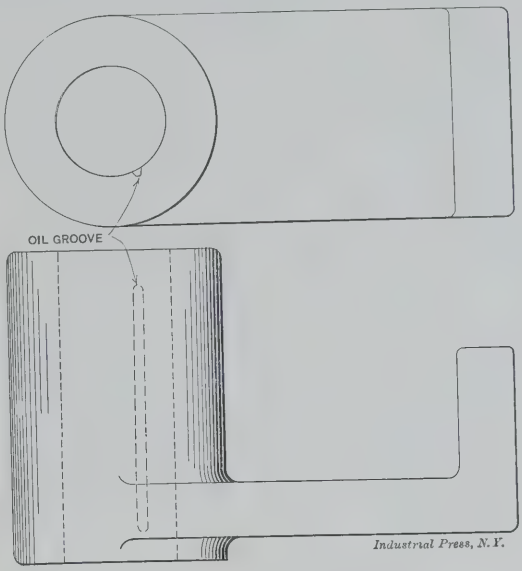
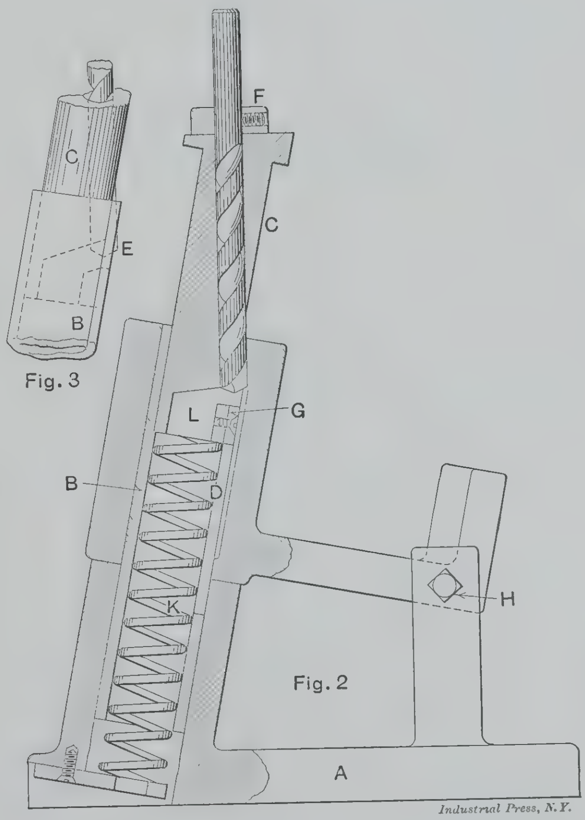


Fig. 1.

The base *A* has an inclined hub in which is forced the hollow bushing *B*, the outside diameter of which is the same as the hole in the bearing. Sliding in this bushing is the plunger *C* through which is drilled a hole perpendicular to the drill table. In one side of the bushing is a slot *D* through which the point of the drill projects a short distance, as shown at *E* in Fig. 3. This cuts the oil groove in the bearing. The amount that the point shall project, and consequently the depth of the oil groove, is regulated by the collar *F* which is held at the desired place on the drill shank by means of a headless setscrew.



Drill Jig for Cutting Oil Grooves.

The key *G* runs in the slot and prevents the bushing from revolving and also acts as a stop to prevent the plunger from coming out of the bushing. The shoulder at the top of the plunger serves as a gage for the depth of the oil groove.

To use the device, the bearing is slipped over the bushing as shown in Fig. 2. A lug and setscrew *H* serve as a gage to locate the groove at the proper place in the bearing. The drill is fed down through the plunger as far as the collar *F* will allow and then drill and plunger together are fed down through the bearing until stopped by the shoulder on the plunger. The base *A* is left free to slide along the drill table to provide for the change of position due to the inclination of the plunger.

When the drill is withdrawn a spring *K* returns the plunger to its original position. A hole *L*, drilled in the end and side of the plunger, allows for the escape of the chips. As the cut is very light the drill may be run at a high speed and rapid feed. Charles Thiel.

Lawrence, Mass.

TOOL FOR TURNING BALL BEARING RINGS.

Editor Machinery:

At a shop with which I was connected we were making pieces, as shown in Fig. 1, at the rate of 1,200 per day. They were ball race rings for use in the steering heads of cycles. It was necessary that the groove should finish perfectly smooth, which necessitated continual grinding of the tool. The first tool we tried consisted of a shank containing three loose cutters, with a ring and set pins to hold them in position. This worked very nicely as regards finish, and we used it for a considerable time. The loose cutters were cut at an angle as shown in Fig. 2. When made in this way they could be ground without losing their shape, which of course was absolutely necessary. To find anything to beat this for cheapness appeared somewhat difficult, but we have since made a tool that does beat it, not only in cheapness, but likewise in convenience of grinding and setting. When replacing the loose tools after grinding considerable time was wasted in resetting; it is obvious, that only a slight variation in the diameter of the groove would make a defective bearing, as the rings are used in pairs.

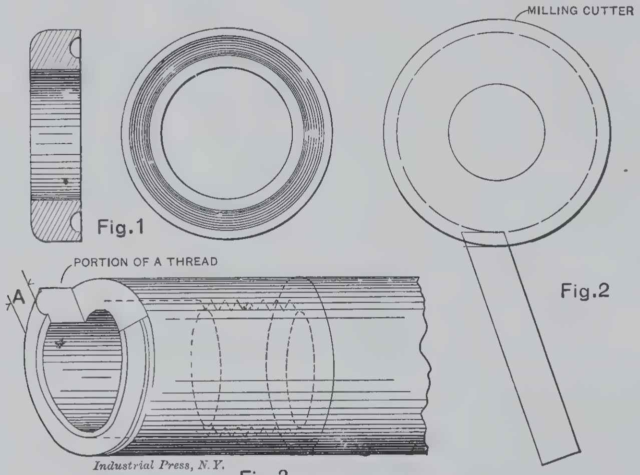


Fig.3

Formed Cutter for Annular Grooves.

The tool shown in Fig. 3 is so simple that it can be ground and reset by the operator, thus dispensing with the aid of a toolmaker. One of these tools has made as many as 6,000 pieces before it was worn out. After hardening, I find it necessary to grind about ⅛ inch off the cutting edge before using, owing to spring in turning tool, which causes the tool to run off at *A*, and so round the cutting edge, causing it to rub; in fact the first one I made would not cut at all through neglecting to do this.

Birmingham, Eng. J. C. Hafner.

SOME HINTS FOR DRAFTSMEN.

Editor Machinery:

Many draftsmen have a habit, and a very good one, of covering the drawing board at night. The majority use a sheet of paper for this purpose; the writer has found that a piece of table oilcloth forms the best covering, as it will not tear; it is heavy, therefore lies flat, and is cheap. In regard to the color to select, white is to be preferred, as dirt can be easily seen on it. To clean, just wipe the glazed side with a damp rag; the rough or unglazed side should be placed next to the drawing. For convenience and to prevent its cracking, tack a stick of wood at one end; it can then be rolled up when not in use.

Frequently a little drop of ink gets down to the edge of the tee-square; the draftsman sees it, and nine times out of ten he pulls his tee-square downward, with the result that he has a very beautiful ink spot ornamenting his drawing. To prevent this it is a good plan to take a slight shaving from the bottom edge of the blade of the tee-square. This can be readily done by scraping the edge with a piece of glass. Triangles may also be treated in this way.

In most cases where it is necessary to erase a small part of a finished drawing it cannot be done without erasing a number of other lines, which, of course, adds to the pleasure of the draftsman, that is, if he is a saint. If, however, the draftsman will take a piece of waste drawing paper and cut out an opening a trifle larger than the portion to be erased and place this over the drawing, then by holding it firmly in place with one hand, he may erase the portion without disturbing any of the other lines. When the part to be erased is circular the opening in the piece of drawing paper is best made by using the low dividers set to the proper radius and turning it around until the paper is cut through.

In regard to the stool used by draftsmen, the writer does not like those with a solid wood seat, as a lake is likely to be formed in the hollow by an innocent chap walking by with a wet sponge accidentally losing some of its water, much to the discomfiture of the owner of the stool when he sits down, and to the amusement of the other occupants of the room.

New York. Charles G. Peker.

AN IMPROVED SPANNER.

Editor Machinery:

The spanner shown in Fig. 1 may not be new to all your readers, but it is an improvement over the form shown in Fig. 2, which is the kind usually sent out with drill chucks, etc. The trouble with the old kind is its propensity to act as a lever with the fulcrum at *A*, in which case the hook *B* draws out of the notch so that the spanner slips off. In fact, it is not uncommon to see a workman using a bar or some near-by tool to hold the hook into its notch while the chuck is being turned. In the construction shown in Fig. 1 a hole is drilled into the handle into which a pin *C* is driven which will fit loosely into a hole in the chuck. In using this spanner it is necessary to push instead of pulling upon the handle.

W. H. S.

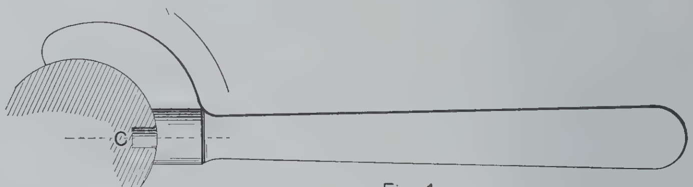


Fig. 1

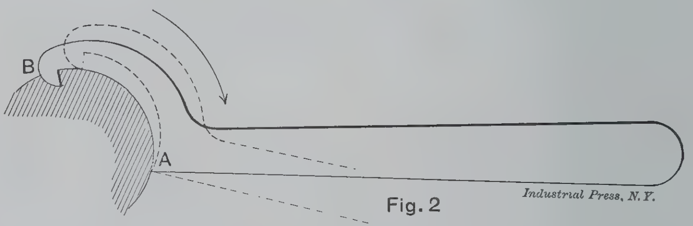


Fig. 2

* * *

Tests were conducted last May by the Automobile Club of America to determine the distance in which an automobile can be brought to a full stop by the application of the brake, when running at different speeds. Seventeen automobiles of different types were tested and their speeds were estimated by running them over a course of 1/10 mile. The average results as reported by the technical committee of the club, were as follows: Running at about eight miles an hour, the vehicles stopped at an average distance of nine feet; at a 15-mile speed the stop was accomplished in an average of 29 feet, and at 20 miles the average distance was 53 feet.

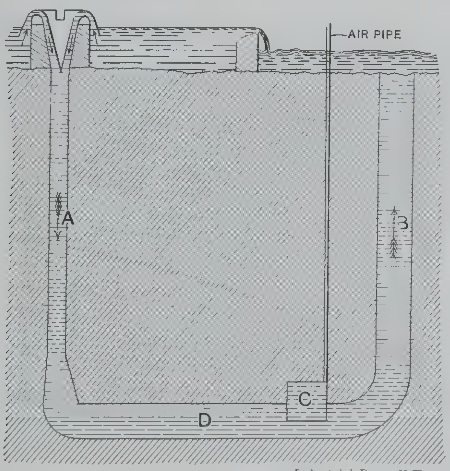
HYDRAULIC COMPRESSION OF AIR.*

METHODS OF COMPRESSING AIR BY FALLING WATER—THE EFFICIENCY OF THIS METHOD.

Probably one of the oldest applications of the use of water power to the wants of man was a form of hydraulic air compressor which operated as an entrainment apparatus. This was the well-known water bellows or trompe of the Catalan forges.

This apparatus, briefly described, consisted of a bamboo pole, disposed at a slight inclination from the perpendicular, into the upper end of which a stream of water was led, entraining air with it in its downward passage. The low end of this bamboo pole was introduced into a bag made of the skin of some animal, the air being allowed to escape from the water into the upper part of the bag, whence it was led by pipes or tuyeres to the forge, the water being allowed to escape from the lower edge of the bag. From this original device a great many improvements have been worked out, and besides this a number of other forms of hydraulic air compressors, or of compressors using other liquids for compressing air or other gases, have been designed.

One of the first inventions carrying out this idea was made by J. P. Frizell, Boston, Mass. His invention made use of an inverted syphon having a considerable horizontal run *D* between the two legs *A* and *B*. A stream of water was led into the upper end of the longer leg *A*, and at the top of the horizontal run *D* between the two legs of the syphon was provided an enlarged chamber *C* in which the air separated from the water. The water was then led off from the lower part of this air chamber and passed off through the short leg *B* of the syphon, the pressure of the air accumulated in the air chamber being therefore due to the height of water maintained in the shorter leg of the syphon. This application of carrying upward the water, after the air was separated from it, so as to produce a considerable pressure upon the air, seems to have been original with Mr. Frizell, and in this feature his device differs from the old trompe.



Industrial Press, N.Y.

Fig. 1. Frizell System.

Another device, Fig. 2, differing somewhat from that of Mr. Frizell, was invented by A. Baloche and A. Krahnass in 1885, and consisted of a syphon *B* carrying water from an upper to a lower reservoir, the lower end of the syphon being projected through an inverted vessel *R* placed nearly at the bottom of the second reservoir. Just beyond the bend of the syphon and in line with the axis of its longer leg, an air pipe *T* projected into the descending leg of the syphon. This entrained the air with the descending column and carried it down into the inverted chamber *R*, from which the air escaped at the top, while the water passed out from the bottom into the lower reservoir. This apparatus produced pressure on the air in the top of the inverted chamber, due to the height of the water column upon it.

Another device, Fig. 3, patented by Thomas Arthur in 1888, differs from the last in having a stream of water led directly into the top of the vertical pipe *A*. Inserted into the mouth of this pipe was a double cylindrical cone *C* forming an annular air passage between it and the walls of pipe *A*.

Owing to the increase in the velocity of the water in passing through the narrow throat of the double cone, air is inhaled through the pipe *D*, through the annular space mentioned and through perforations in the lower cone, and is entrained with the falling water.

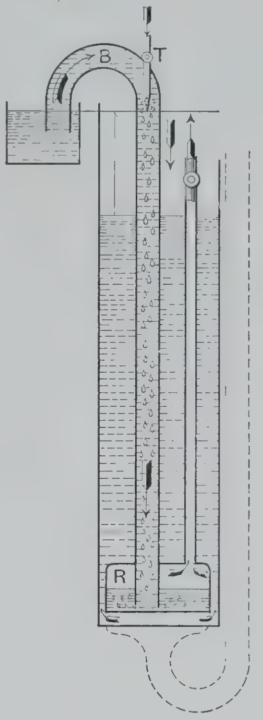
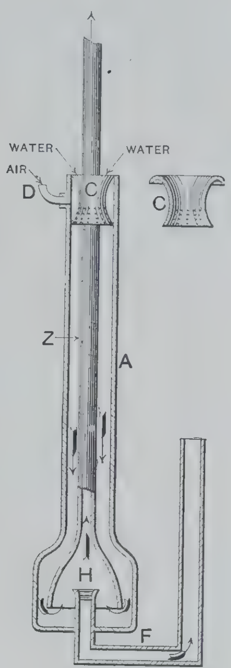


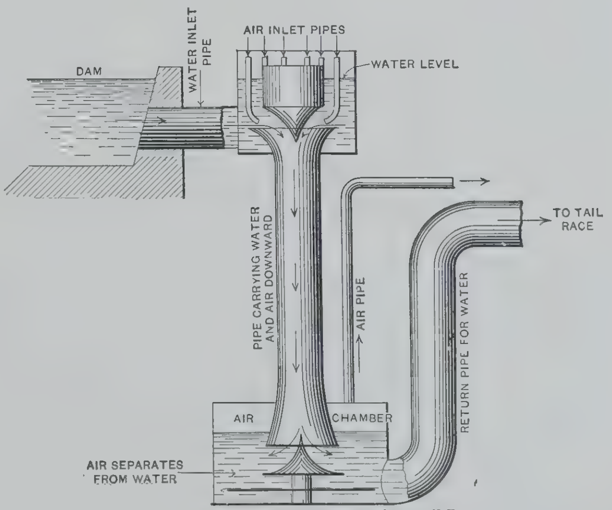
Fig. 2.



Industrial Press, N.Y.

Fig. 3.

Through the downflow pipe *A* rises a vertical delivery pipe *Z* for the compressed air, having its lower end *H* enlarged and open at the bottom. Projecting upward into this enlarged air-delivery pipe was a water escape pipe *F* through which the water passed after having parted with the air. The escape pipe was in the form of an inverted syphon and maintained on the air in the delivery pipe *Z* a pressure due to the elevation of the water at the discharge point above the air line in the large end of the delivery pipe.



Industrial Press, N.Y.

Fig. 4. Taylor System.

A number of other patents on apparatus of this type have been issued to Charles H. Taylor. His invention, Fig. 4, consisted principally of a downflow passage having an enlarged chamber at the bottom and an enlarged tank at the top. A series of small air pipes project into the mouth of the water inlet from the large chamber at the upper end of the vertically descending passage, so as to cause a number of small jets of air to be entrained by the water, Taylor seemingly having been the first to introduce the plan of dividing the air inlets into a multiplicity of smaller apertures evenly distributed over the area of the water inlet.

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* From a paper by Wm. O. Webber read before the N. E. Cotton Manufacturers' Association.

The first of these compressors on the Taylor principle was installed at Magog, Quebec, to furnish power for the print works of the Dominion Cotton Mills Company. The head of water is 22 feet; the downflow pipe extends downward through a vertical shaft 10 feet square in cross section and 128 feet deep. At the bottom of the shaft the compressor pipe enters a large tank, which is known as the air chamber and separator.

A series of very careful tests demonstrated that with 19.5 feet head, using 4,292 cubic feet of water per minute, was recovered the equivalent of 1,148 cubic feet of free air per minute, which would represent 248 cubic feet of air per minute compressed to 53.3 pounds pressure, showing that out of a gross water horse power of 158.1, 111.7 horse power of effective work in compressing air was accomplished, giving therefore an efficiency of 71 per cent. In the tests at Magog 81 horse power was recovered, using as a motor an old Corliss engine without any changes in the valve gear; this would represent a total efficiency of work, recovered from the falling water, of 51.2 per cent.

When the compressed air was pre-heated to 267 degrees Fahrenheit, before being used in the engine, 111 horse power was recovered, using 115 pounds of coke per hour, which would equal 23 horse power. The efficiency of work recovered from the falling water and the fuel burned would be, therefore, about 61½ per cent. On the basis of Prof. Riedler's experiments, requiring only 425 cubic feet of air per brake horse power per hour, when pre-heated to 300 degrees Fahrenheit, and used in a hot air jacketed cylinder, the total efficiency secured would have been about 87½ per cent.

In what follows will now be given an estimate of the probable efficiency of different methods of using the power of a water fall. First are tabulated the results that it is reasonable to expect when using turbines and transmitting power by belts and shafting; second by electrical transmission from generators connected to turbines; and finally by an hydraulic air compressor. The compressor, it will be seen, gives the apparently remarkable result of over 100 per cent efficiency. This is due to pre-heating and moistening the air, however, and not to a reversal of mechanical laws.

Given horse power of water	1,000	horse power.
Wheels at 85 per cent efficiency	850	“ “
Shafting, pulleys and belts at 80 per cent	680	“ “

or a total net result of 68 per cent, wheels being at full gate and allowing the minimum loss for friction of shafting.

With wheels as usually run at part gate, the results would be as follows:

Given horse power of water	1,000	horse power.
Wheels at 75 per cent efficiency	750	“ “
Shafting, pulleys and belts at 50 per cent (average)	375	“ “

or 37½ per cent of the whole power; both of the above being directly at the site of the water power.

In order to transmit power to a distance, we must take again:

Horse power of water	1,000	horse power.
Wheels at 85 per cent efficiency	850	“ “
Generators at 92 per cent efficiency	780	“ “
Transformers at 92 per cent efficiency	720	“ “
Line at 95 per cent efficiency	680	“ “
Converters at 92 per cent efficiency	625	“ “
or about 62½ per cent of the whole.		
and direct connected with motors at 90 per cent efficiency	565	“ “
or 56½ per cent of the whole, or if belted at 90 per cent efficiency	508	“ “
say 51 per cent of the whole.		

By the use of an hydraulic air compressor:

Horse power of water	1,000	horse power.
Hydraulic compressor at 75 per cent efficiency	750	“ “
Pipe line efficiency at 98 per cent	735	“ “
Pre-heating dry air adds 50 per cent. Moistening dry air adds 50 per cent. = 100 per cent	1,470	“ “
Air engines or motors at 78 per cent efficiency or 114.5 per cent.	1,145	“ “
and if belted at 90 per cent efficiency or 103 per cent of the whole as a resultant effect.	1,030	“ “

To estimate the efficiency of hydraulic compressing, taking into account the water absorbed by the air and the coal used in heating the air, we have the following:

The weight of a cubic foot of compressed air at 85 pounds and at 70 degrees Fahrenheit, equals .58.

One thousand horse power would represent 750,000 cubic feet of 85-pound air per hour; this would equal 382,000 pounds of air, and as one pound of air will absorb .58 pounds of water, we would require 221,500 pounds of water per hour. The labor represented by forcing 221,500 pounds of water per hour, equal to 3,700 per minute, against 85 pounds pressure, equals 195.5 feet would be $\frac{195.5 \times 3700}{33,000}$ equals about 22 horse power, and as pumps give an efficiency of 50 per cent, equals 44 horse power of work by pump, or 4.4 per cent of the whole 1,000 horse power, this is therefore to be deducted: The coal used in heating the air, which is about one-half pound per horse power per hour, would also represent an amount of work equal to 75 horse power, or 7½ per cent of the whole 1,000 horse power. This added to the 4.4 per cent as above would equal an amount of 13 per cent to be deducted, equals 87 per cent of the whole horse power, or 1,030 × .87 = .896, or 89.6 per cent as a final result of all, as against 56½ per cent by electricity, or 68 per cent by water wheels at their best, or 37½ per cent by water wheels at the average.

That our results are within the bounds of reason is shown by the fact that 75 per cent × 98 per cent × 200 per cent × 78 per cent × 87 per cent = 99.5 per cent.

* * *

EVAPORATIVE CONDENSER.

Since the ordinary jet or surface condenser for steam engines requires anywhere from 20 to 40 pounds, or more, condensing water per pound of steam delivered to it from the engine, it follows that a type of condenser that consumes, say, only 6-10 pound of water per pound of steam should possess a considerable economical advantage where water rates are high. The July issue of *Power* contains a description of what is called an evaporative condenser in which a spray of water is drawn through the tubes of a surface condenser, together with a current of air, by a fan exhauster. The success of the device depends on the principle that the evaporation of one pound of water requires as many heat units as will be abstracted from one pound of steam when it is condensed, pressures being equal of course. So if a steam coil containing steam at atmospheric pressure (temperature 212 degrees F.) was sprayed with water, each pound of water evaporated on the exterior should in theory condense one pound of steam on the interior of the coil. In this device a portion of the heat is absorbed by the current of air and the unevaporated water. A test was made in Chicago of this condenser connected to a simple automatic engine 12½ by 20 inches running at 156 turns per minute for a period of 16 hours; steam pressure 90 pounds. The pounds of steam condensed was 24,010; total consumption of spray water, 48,000 pounds; less spray water returned, 33,600 pounds; actual amount of spray water consumed, 14,390 pounds.

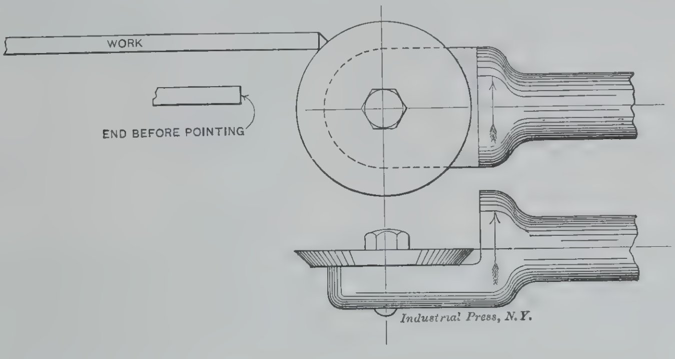
* * *

The proper ratio of the diameter of a wire cable to the pulley sheaves over which it runs should be carefully observed if the maximum life of the cable is desired. Experience has shown that it should not be much less than one to forty where the cable is in constant use, as in elevators. This means that if the cable is one inch in diameter the sheaves should be forty inches in diameter or more. It makes no difference whether the cable makes a turn of 180 degrees or less, the stress on the cable is just the same so long as it is constrained to the curvature of the sheave for even a short arc of its circumference. To illustrate the effect of sheave diameter on cable life the experience of a writer in a contemporary may be mentioned. He found a plant in which two five-eighth-inch cables passed over an 18-inch sheave carrying a 700-pound counterweight. The factor of safety was thirty to one, yet the life of the cables was only two years. One-half inch cables were substituted, which reduced the factor of safety to twenty-five, but doubled the life of the cables.

CONTRIBUTED NOTES AND SHOP KINKS.

POINTING TOOL HAVING CIRCULAR CUTTER.

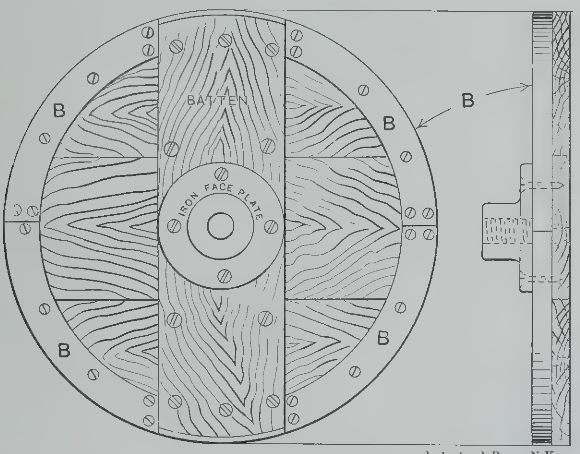
E. M. Lehman, Chicago, Ill., designed and used the pointing tool here shown, some ten years ago. The cutter is about two inches in diameter, which therefore gives about six inches of cutting edge that can be used and made dull before it is necessary to sharpen it. When one section of the cutting edge becomes dull, the cap screw is loosened and the cutter shifted around about 3-16 inch, thus bringing a sharp section into contact with the work, and so on around until the whole circumference is made dull.



Industrial Press, N.Y.

PATTERNMAKERS' LATHE FACEPLATE.

Patternmaker writes: In pattern shops when making face plates it is common practice to take two or three boards 1¼ inch or 1½ inch thick, as the size may require, and screw the batten on back, as shown in the sketch. I go just a little farther and screw on segments of the same thickness as the batten shown at *B*. In this way you more than pay the cost when putting hand screws on work. It is annoying to find your hand screw must be put on just at the edge of batten, but with segments the back is even all round.

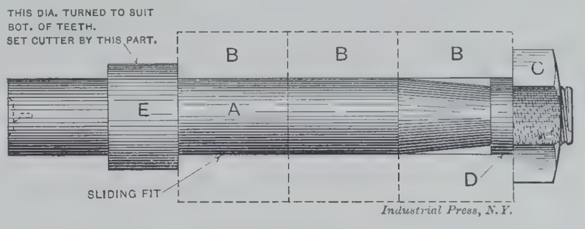


Industrial Press, N.Y.

Lathe Faceplate.

COMBINATION ARBOR.

Robert A. Lachman, Chicago, Ill., had occasion to cut several steel pinions 4 P. and 17 T. Some of the pinions had straight holes and others taper holes. Most of the machines for which the pinions were made required two with straight holes and one with a taper hole, all being of the same diameter. Some of the machines, however, required all three pinions to have straight holes. It was desirable that the three pinions required for each machine be cut at the same setting so an arbor was made that would carry two straight-hole pinions and one taper hole, or three pinions having straight holes. The pinions were bored and faced on one side while in the chuck and the other side was faced while mounted on an arbor so that the combination arbor shown here was used only for turning the external diameter in the lathe and cutting the teeth in the gear cutter. The cut shows how a straight-hole pinion was mounted on the part of the mandrel intended for pinions having taper holes. A ring *D* was made ¾ inch thick and bored to fit the straight part of the mandrel which had been turned back of the thread. The external diameter of the ring was made the same as that of the mandrel. In this manner the end pinion was supported at both ends in a satisfactory manner. The short distance cut away from the taper bearing did no harm, as there was ample bearing left for supporting the taper hole pinions. The collar *E* was turned to the same diameter externally as the bottoms of the teeth spaces so that it could be used for setting the cutter before mounting the pinion blanks on it. This obviated all chance of error in depth of tooth space when making the setting.


THIS DIA. TURNED TO SUIT BOT. OF TEETH. SET CUTTER BY THIS PART.
B
B
B
C
E
A
D
SLIDING FIT
Industrial Press, N.Y.

Combination Arbor.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published

1. Connecticut. What is the best method of reboring the boxes of engine lathes; can they be bored on the ways better than some other way? The lower half of back boxes have a screw in them to take up the end motion of spindle. 2. What is the usual allowance for making shrinking fits, as in shrinking on collars, etc.? Is it advisable under any circumstances to cool with water? 3. Small lathes are often made so that the back bearing is formed by the end of spindle running in a steel bushing (tapered usually); which should be hardened, the end of spindle, or the bushing, or both?

A. We judge from the first inquiry that you have several lathes, the main bearings of which have become worn and are to be rebored. We prefer to mount the headstock on ways and then bore with a rotating bar arranged to feed through the work, as in the case of the bar of a horizontal boring machine. If the boring is to be done on a lathe, however, such an arrangement is not easy to rig up. You might find it feasible to bore the bearings with the headstock in place. We would like to have readers submit suggestions for doing the work. 2. Allow .002 inch per inch diameter. Yes, cool with water; otherwise the center will become hot and will not cool until after the outside parts have cooled. When the center finally cools it will then contract and the fit may be destroyed. 3. When both the spindle and its seat are of steel, both should be hardened.

2. Subscriber. Please explain a method for finding gears to cut worms in a lathe to mesh with worm gears of diametrical pitch. 2. How can I find the angle of the teeth of worm gears other than by laying it out on paper? I want a method that can be used in a shop where there is no drawing to go by.

A. To start with the simplest case, suppose it is desired to cut a worm to mesh with a worm wheel of one diametrical pitch, and that the lathe has a lead screw with one thread per inch, or a screw of one inch pitch. The circular pitch of one diametrical pitch gear is 3.1416 inches, and a very close approximation to this decimal is the fraction 22—7. The worm, therefore, must have a pitch of 3.1416 inches, or 22—7 inches. This fraction, 22—7 should be memorized, as it is the only number that one need have at hand in making change gear calculations for worm threads. In the lathe mentioned the lead screw would advance the tool one inch for every revolution of the screw and would thus have to turn 3.1416 times to advance the tool 3.1416 inches. In other words, the lead screw should turn 3.1416 times as fast as the worm which is being cut. As the fraction 22—7 is equivalent to 3.1416, this result would be accomplished with a 22-tooth gear on the stud and a 7-tooth pinion on the lead screw, or gears in this ratio, say, 44 on stud and 14 on screw. Now suppose that instead of a lead screw of one thread per inch there was one with three threads per inch. The screw would then have to turn three times as fast as before, to accomplish which the gear on the stud should be three times as large, or else the gear on the screw three times as small as before. The gearing should be in the ratio, therefore, of 3 × 22—7, or 66—7. If the lead screw had four threads per inch the gearing should be in the ratio of 88—7, and if six threads, in the ratio of 132—7. Assume, finally, that it is desired to cut a worm of some pitch other than one, say, to mesh with a worm wheel of four diametrical pitch. The threads of the worm would then be four times as near together as before and the lead screw should turn only one-fourth as fast. The gear on the lead screw could thus be four times as large as in the first example, or the gear on the stud four times as small. With a three-pitch lead screw the gearing should be in the ratio of 66—28; with the four-pitch screw, 88—28, and with the six-pitch screw, 132—28. If a worm for a six-pitch worm wheel were desired, then for the three cases the gearing would be in the ratio of 66—42, 88—42 and 132—42, respectively. Of course it is understood that these fractions may be reduced to their lower terms, in order to reduce the size of the gears. Thus, for a three-pitch lead screw and four-pitch worm we found the ratio 66—28, but it would be more natural to select gears 33 and 14 instead, which bear the same ratio as the others. The foregoing calculations apply only to lathes in which the spindle and lead screw make the same number of turns with equal gears. Where the spindle turns faster or slower than the lead screw, with equal change gears, allowance must be made for this. With compound-geared lathes the simplest plan is to use equal intermediate gears and to put gears on the stud and screw, as calculated above. 2.—The simplest plan is to lay out the angle, even in the shop, as it is very easily done with a scale and try square. In making the calculation, reference must be had to a table of natural tangents. Divide the circular pitch of the worm wheel by the pitch circumference of the worm. The quotient will be the tangent of the angle made by the tooth with the axis of the gear. Where a worm gear is hobbed it is not necessary to have this angle; but if a spur gear with inclined teeth is used for the worm gear, it of course is necessary.

* * *

NUTS FOR CLAMPING BOLTS—PLANER JIG.

The nuts shown in Fig. 1 are samples of clamping bolt nuts used in the shops of the Cincinnati Planer Co. for planers and boring mills. This style of nut replaces the old-fashioned T-head bolt and is said to have many advantages over it. It may be moved along the slots to any point desired and used in connection with a common machine bolt or cap screw. It does not break away the edges of table slots and clamping bolts used with these nuts may be loosened up without the work jumping out of place, as has been the experience of many of us with the common T-head bolts. It also gives a more secure hold, as it has a longer and more rigid bearing in the table slot.

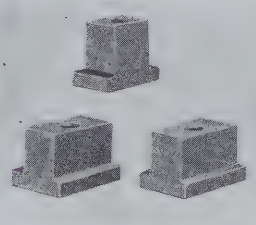


Fig. 1.

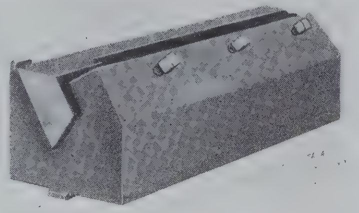


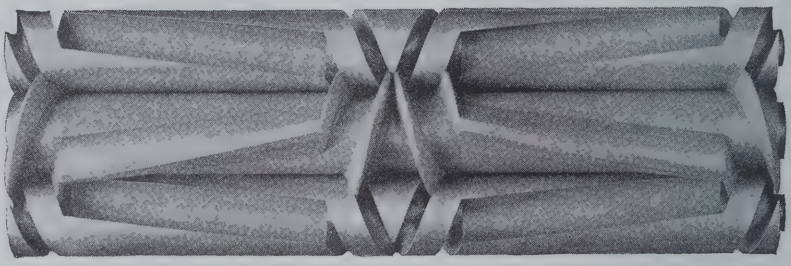
Fig. 2.

Another good scheme used in the same shops, is a simple and efficient jig for planing the edges of dovetailed strips to 30 degrees angle without swiveling the planer heads. The pieces are first planed top and bottom to the required thickness and then the edges are planed in this jig. The slot in the jig is planed out to the required angle so that the upper edge of the piece to be planed is parallel to the planer table. Fig. 2 shows a short piece in a jig ready for planing. Three set screws are provided for clamping it and a lug acts as a stop to take the pressure of the cut off the screws. There is a height gage to which the planer tool is set for finishing. All work planed in this jig is sure to be exactly of the same angle and size.

* * *

HIGH-SPEED HELICAL GEARS.

The Boston Gear Works, Boston, Mass., are devoting a great deal of attention to the construction of gear wheels to run at extremely high speeds. All of their gears for high-speed work are of metal instead of rawhide or fiber so extensively used for this purpose. While metal gears have obvious advantages over those of softer material, they must be made with great accuracy to run smoothly at high speed; otherwise the impact of the teeth makes the gears noisy. The Boston Gear Works advocate some form of helical gear and they are prepared to manufacture either spiral gears or gears of the herring-bone type which will run quietly at extremely high speeds. These gears, however, must be cut with great care and their experience is that the index arrangement supplied with standard milling machines is not accurate enough for the purpose. A first-class spur gear cut by a modern gear-cutting machine with its large dividing wheel will run with less noise than an ordinary spiral or herring-bone gear, cut on the milling machine, and spaced with its small index plate.



A Set of Three Helical Gears to Run at 5000 Revolutions a Minute.

The style of herring-bone gear recommended is one with the teeth making a much less angle (usually about 10 degrees) with a line parallel with the axis of the gear than in the old style herring bone gear having teeth usually at about 45 degrees with this line. The accompanying illustration shows three special helical gears designed for speeds of 3,000 to 5,000 revolutions per minute. These gears are for special work, of the nature of which we are not informed, except that it was necessary to have three shafts running very near together. The gears have only two teeth each and the angle made by the spiral with the axis of the gear is very small. Gears with two teeth will not run together, however, unless the faces of the gears are long enough for the spiral teeth to make about half a revolution from end to end of the gear and thus engage in the opposite tooth before the first pair of teeth are out of mesh. In this case the angle of the spiral is so small that the faces of the gears would have been excessively long under this condition. The difficulty was overcome by having the angle of the spirals change abruptly at the ends of the teeth so that there is always some portion of each tooth that is driving, no matter what position the gears are in. The difficulty in matching the ends of the teeth where the angles at the center converge and those at the ends diverge, as in this case, can well be appreciated, especially where the gears must run at such high rotative speeds.

* * *

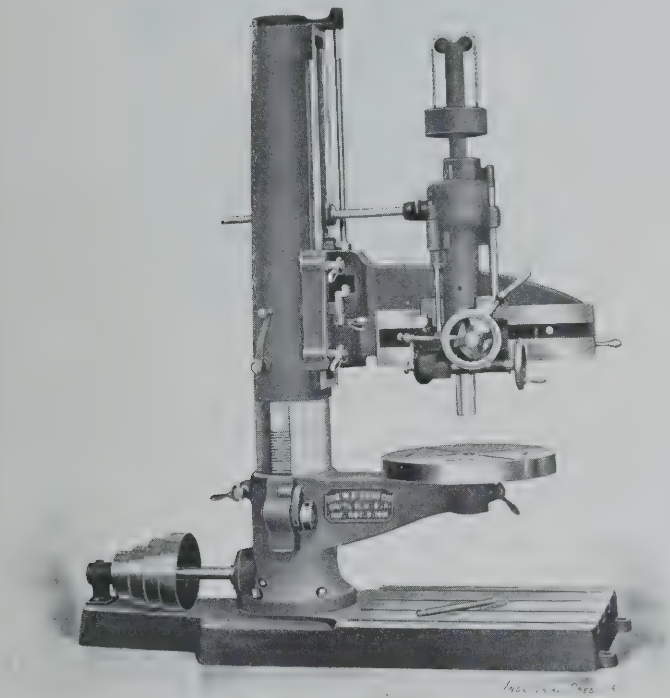
For the purpose of getting the approximate volume of a sphere, it is usually near enough, for the purpose of a rough estimate, to say that it is equal to one-half that of a cube having edges of the same length as the diameter of the sphere. Thus to get the cubic contents of a sphere 3 feet in diameter, multiply the diameter by itself two times and the result by ½; the final product, 13½ cubic feet, is the approximate volume. Thus, 3×3×3×½=13½ cubic feet. The actual volume is 3×3×3×.5236=14.1372 cubic feet.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

IMPROVED RADIAL DRILL.

We illustrate herewith an improved radial drill built by the Wm. E. Gang Co., of Cincinnati. This is a machine unique in some of its features and well adapted to the requirements of an every-day shop tool. The frame parts are well proportioned, and as evidence of their stiffness it may be mentioned that the seat of the round table is faced off with an inserted tooth mill 9 inches in diameter, fed to its cut by means of the regular gear traversing mechanism, consisting of rack, pinion and hand wheel.



Radial Drill made by the Wm. E. Gang Co.

The lower end of the column is turned to fit in the stump, allowing the arm to swing through a complete circle on its ball bearing. The upper end of the column has a flat seat for the arm, is planed with dovetail flanges at the edges of the arm seat, and back of these again are flat seats for the clamps, which hold the arm in position and also take up any wear incident to raising and lowering the arm. Two screws with handles attached, working in nuts beveled to fit the edges of the arm seat, both clamp the arm and align it vertically. Any tendency to spring the column in clamping the arm is overcome by fitting a square gib in the opening provided for vertical movements of the horizontal driving shaft.

The arm is of box section, well ribbed, and is raised and lowered by means of a stationary screw, a revolving nut and tumbler gears, the movement being controlled by the small lever shown directly between the clamping screws. The head is provided with an ample number of feeds by hand or power, a quick return movement for spindle, and is traversed along the arm by means of rack, pinion and the handwheel at the front.

To concentrate all heavy stress of driving at the spindle three large gears—for ordinary drilling, for heavy boring and tapping, and for reverse in tapping—are placed directly on the spindle. The back gears are just behind them. The upper part of the head is made to entirely surround these driving gears, thus eliminating all attached bearings, affording an excellent protection to the working parts and insuring the workman against injury. A lever at the right of the head enables the operator to quickly start, reverse, connect or disconnect the back gears.

A friction feed is provided and any desired change is obtained instantly by turning the knurled knob at the left of the head.

Any one of four styles of table—a round table, a plain square table, a plain swiveling table, or a worm swiveling table—can be furnished with this machine.

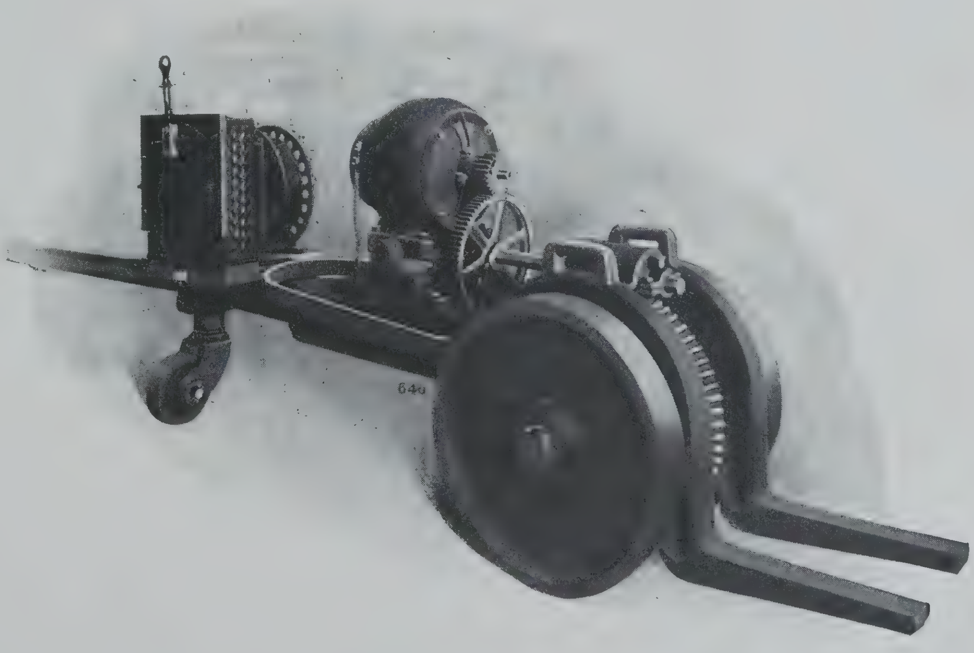
The base is so designed as to give ample strength and stiffness, to provide ample working surface and to occupy no unnecessary floor space.

The machine is provided with eight rates of spindle speed. Others may be added to cover special cases.

NOVEL FOUNDRY TRUCK.

The Northern Electrical Mfg. Co., Madison, Wis., have brought out an electrically-driven foundry truck, shown in the accompanying illustration. The first one of these was built for use in a malleable iron foundry. The old method of placing pots containing the castings in the ovens and taking them out again was an expensive and troublesome operation, requiring from six to twelve men. To remedy this, they equipped the truck here illustrated.

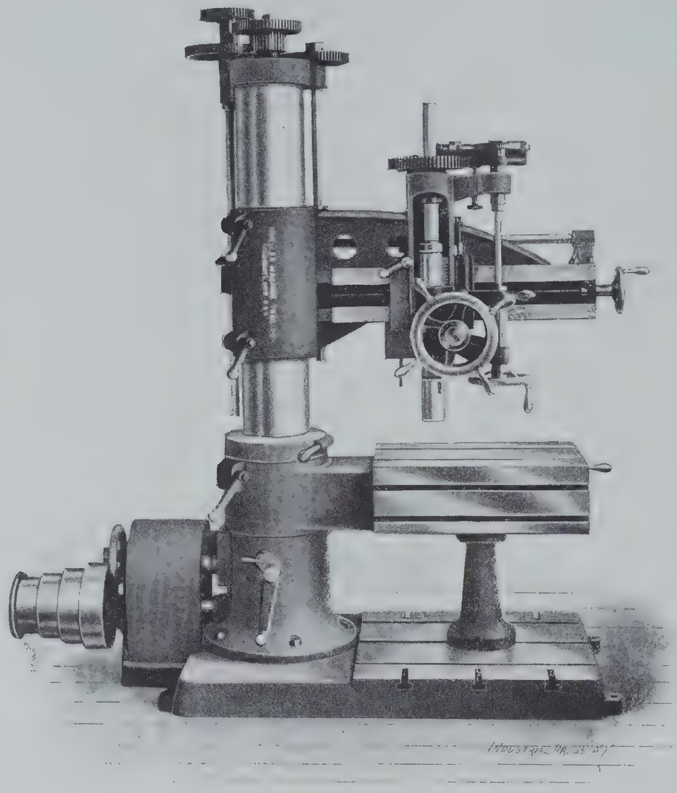
This consists of a "Northern" back-geared motor connected to the truck shaft by means of a worm and gear. On this shaft are mounted the two truck wheels that are keyed fast to the shaft. The forks on the truck are mounted on an eccentric, the eccentric being operated by a lever that is shown between the motor and the controlling apparatus. By raising this lever the forks are dropped down low enough to be shoved in underneath the pot of castings, and by pulling the lever down to the position shown in the cut, the pot of metal is raised. On the front end of the truck is mounted a reel that contains the wire that is paid out automatically as the truck is operated back and forth in the oven. On one side of the reel is mounted a reversible controller that operates the motor. This equipment is so compact and complete that one man can do the work of twelve in a great deal less time than by the old method.



Electrically-driven Foundry Truck.

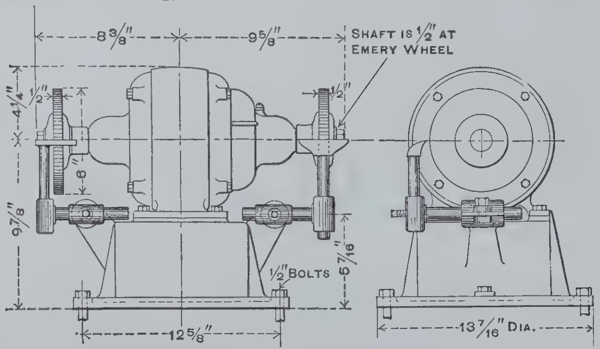
A NEW TWO AND A HALF FOOT RADIAL DRILL

The illustrations here shown are of a new type radial drill, brought out by the Mueller Machine Tool Co., Cincinnati, Ohio. This machine has a pipe-shaped column clamped directly to a heavy well-ribbed base, thereby insuring the utmost rigidity for the arm and work spindle. The arm is supported by a top cap, resting on steel balls and both revolve easily around the column. By shifting the lower crank to right or left, and by the use of a cone pulley, twelve changes of spindle speed are instantly obtained without stopping the countershaft. These twelve speeds are equally divided between the maximum and minimum revolutions of the spindle.


Radial made by Mueller Machine Tool Co.

The lower driving shaft is the only one in motion when the spindle is not used, a feature that prolongs the life of the machine.

A depth gage reading from zero is on the head, which enables the operator to stop the spindle at any point, or it can be set to automatically throw out the feed at a certain depth. A safety stop prevents automatic feeding beyond the limit of the spindle's stroke. A single lever in front of the column operates a pair of friction clutches, and controls all starting, stopping, reversing, as well as elevating and lowering of the arm at an increased speed. Any amount of feed per revolution of spindle between .007 and .021 can be instantly obtained by a small friction wheel on the head. All tightener handles are fitted on cone-shaped screws, and by loosening the nut in front they can be set to clamp at any point in case of wear. The usual quick return to spindle and tapping device are also provided for.

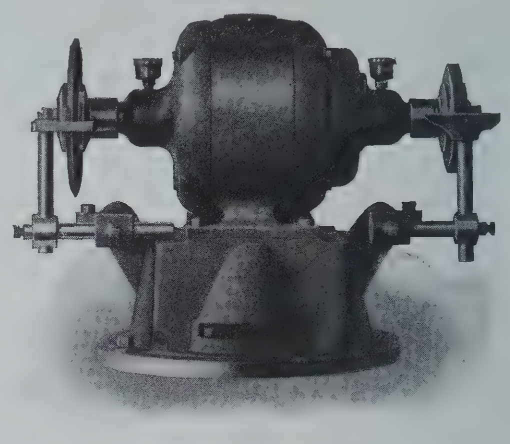


View showing Dimensions of Bench Grinder.

The net weight of machine is 3,000 pounds. It was designed by Mr. Oscar W. Mueller, formerly of the firm Dreses, Mueller & Co.

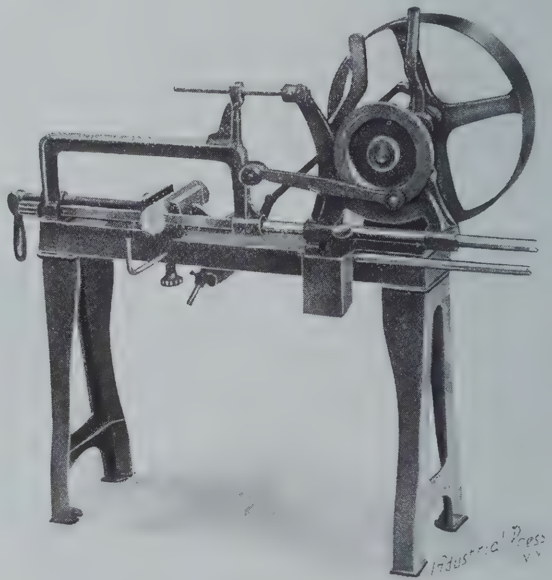
"LITTLE BADGER" GRINDER.

The "Little Badger" grinder shown herewith is a bench grinding machine that has been placed on the market by the Northern Electrical Mfg. Co., Madison, Wis. The dimensions are shown in the line cut, and it will be noted that it is so small that it can be easily set wherever convenient on the bench. The base is heavy enough to keep it from tipping even if not bolted down, while the machine is light enough to be readily portable. The motor is entirely enclosed and is dust-proof. Tool rests are arranged for grinding either on the face or side of the wheel. The bearings are provided with suitable lubricating devices; there is a take-up for wear and end thrust is provided for. An automatic cut-out switch is placed inside the stand, with which to stop and start the motor.


Electrically-driven Bench Grinder.

RAPID-CUT POWER SAW.

The cut herewith shows the improved rapid-cut power saw manufactured by the Robertson Mfg. Co., Buffalo, N. Y. This machine is strong, well made and will cut hard or soft metal up to 4½ inches, round or square. The saw frame is hung in a swinging carriage frame, and the action of the crank automatically relieves the drag of the saw on the return stroke, and thus the saw cuts faster and lasts longer.



Power Saw Cutting Thin Disks from end of a Bar.

The sliding balance weight enables adjustment to be made with the greatest ease for the hardness of metals. The movement of the frame is so true in line with the crank that the full stroke of saw allows the cut to be made with no friction on the saw other than that due to the set of teeth. One hundred and fifty-four cuts have been made of a 2-inch round steel bar with one saw, slicing them off 1-32 inch thick; and, for a test, cuts less than 1-64 inch thick have been taken, perfectly parallel.

When the saw has completed a cut the machine automatically stops. The frame when raised for the next cut is locked by a gravity locking lever, a most convenient device to apply to this type of machine.

The drive pulley is provided with a clutch, a countershaft not being required. The machine is furnished with a stop gage for cutting a number of pieces the same length. The floor space it occupies is 15x34 inches; the height of the machine is 34 inches; the size of pulley, 2½ by 14 inches; the length of stroke, 6 inches.

NEW MODEL MILLING MACHINES.

The Becker-Brainard Milling Machine Co., Hyde Park, Mass., have placed upon the market a new line of plain and universal milling machines from new designs and patterns. These machines, one of which is here illustrated, embody many new features, special attention being given to strength, power and rigidity in order to meet the demands of modern milling machine practice.

In the universal machines the spindle is connected with the change feed mechanism by a train of three spur gears, which eliminates the usual feed pulleys and belt, giving the positive gear drive necessary for heavy and rapid cuts.

The change feed mechanism obviates loss of time in changing gears. The feed is obtained and driven by the main spindle through a train of three spur gears on the back of the machine which drive two nests of change feed gears in the column. By compounding the gears in the upper nest, the various changes of feed are secured, giving, with the quick change in the gear case on the outside of the machine, twenty changes of feed for each spindle speed. Levers, operating the change feed mechanism, are conveniently located on the side of the feed box. All changes may be made by the operator without stopping the machine or changing his position, by the simple movement of the levers, which brings them into the position indicated on the index plate. This index plate has each feed plainly marked on its surface, showing the exact position to which the levers must be brought to give a desired feed per revolution of the spindle. For example, if a feed at the rate of .017 per revolution of the cutter is to be obtained, lever *B*, shown by the cut, is placed in the notch 3 on the lower quadrant *C* and then the lever *A* is brought to the line marked 3 opposite the space .017 on the index plate. The quick-change lever *D* on the lower side of the feed box is then moved to the hole marked "slow" and the desired speed is obtained. Should it be desired to increase the feed, lever *A* is moved so as to point to the line at 3 prime (marked with a dash below) on the index plate and .019 is obtained. If the feed is to be decreased lever *B* is moved to notch 4 on quadrant *C* and .013 is obtained. When the fast feeds are desired, the quick-change lever *D* is thrown into the hole marked "fast" and the same operation performed as described above.

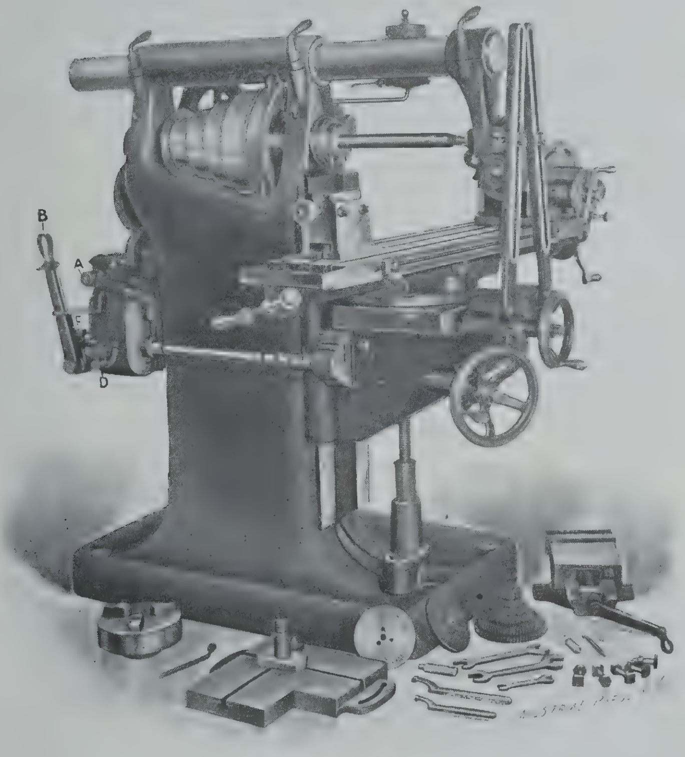


Fig. 1. Becker-Brainard Milling Machine of New Design.

Power is transmitted from the change feed mechanism through the telescopic shaft connecting by gears the longitudinal, transverse and vertical feeds, which are reversed by a lever on the side of the knee. Both transverse and vertical feeds are operated and controlled by a lever, located on the side of the knee, which, when central, disconnects both feeds and when thrown into position for one feed it is impossible to connect the other.

An important feature is a clutch arrangement enclosed in the hubs of the handwheels which operate the vertical movement of the knee and cross movement of the carriage. When either the knee or carriage has been set to the required position, the clutch may be instantly disengaged by pressing in the knob on the front of the handwheel, thereby preventing any accidental change from their fixed position and also preventing the handwheels from revolving when the automatic feeds are thrown in.

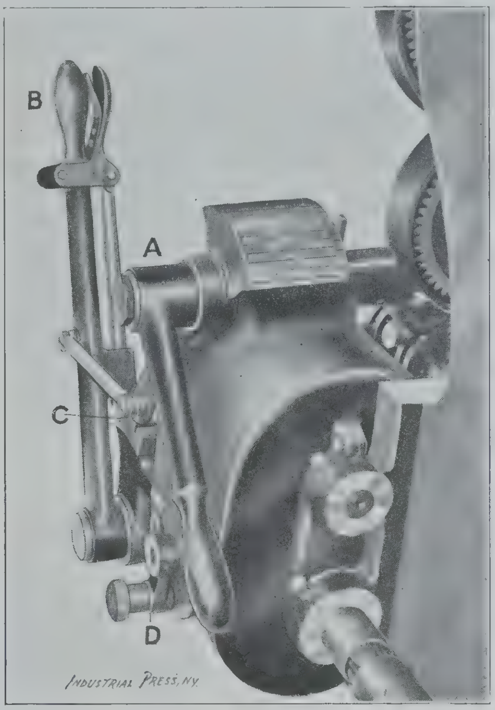


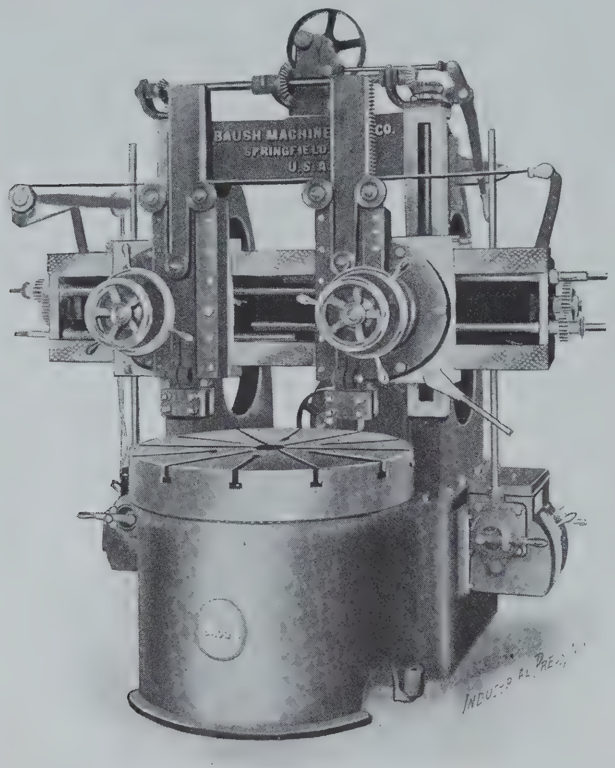
Fig. 2. Feed Box of Becker-Brainard Milling Machine.

The knee, which is of the box type, provided with a telescopic elevating screw, makes holes in the floor unnecessary and allows the machine to be placed regardless of beams or foundations. The thrust of the screw is taken by ball-bearings.

The base of the machine is very solid, thereby absorbing vibration. The arm is a straight steel bar, so that any of the regular attachments can be placed in position without the necessity of removing the arm.

BORING AND TURNING MILLS.

A line of boring and turning mills in sizes 37, 41, 51, 54 and 61-inch is now manufactured by the Baush Machine Tool Co., Springfield, Mass. All sizes of the machines are equipped with a number of devices, making them well adapted for the rapid production of all classes of work within their capacities. The illustration accompanying this description is of the smallest or 37-inch size. All the mills have independent feeds operated by a device on the Hendey-Norton principle. In the 37-inch machine there are 15 changes, ranging from 1-64-inch to 9-16 vertical and from 1-64 to ⅞-inch horizontal, per revolution of table. A change from one to the other can be made almost instantly without stopping the mill. The heads can be operated independently of each other and by means of a split nut and rack and pinion can be moved back and forth very quickly. The cross rail is raised and lowered by power, the pulley being placed in the center. It is started and stopped by a lever, and the pulley is belted from below. The table can be removed and replaced by an independent or a universal chuck. It has an outer bearing with a self-oiling device which keeps it constantly lubricated. The main bearing is large and long with a hole through the center to allow the chips to pass through to the bottom of the mill without clogging, from whence they can be removed. Arrangements have been made so that the mills be driven by a motor by removing the cone and bearing and attaching the motor to the bed. The back gears are so located that they can be thrown in and out by means of a lever, without the use of a lock nut.



Thirty-seven inch Boring Mill—one of a New Series.

IMPROVEMENTS IN THE GOULD & EBERHARDT SHAPER.

Gould & Eberhardt, Newark, N. J., are applying an improved sleeve cone support to their shapers and other machine tools, which is designed to overcome the evils arising from an overhanging cone without outer bearing support. The cone *C*, Fig. 1, is supported on a sleeve bearing *B* and drives the shaft *A* through the clutch flange *D*. Connection is made between the cone *C* and the flange by means of taper pins, the pins being a tight fit in the flange and an easy fit in the cone. By employing this mode of construction the stress of the driving belt is carried entirely by the rigid sleeve journal, which is bolted by means of a flange to the side wall *E* of the shaper or other machine to which it may be applied. The driving shaft having only to transmit the torsional stress incident to driving the machine, the wear on it is reduced to a minimum, which insures the proper meshing of the driving gears indefinitely. With ordinary attention in the matter of lubrication this bearing should outlast the machine. All parts of the sleeve bearing are cast iron.

Fig. 2 shows a shaper to which the improved cone support has been applied. This machine also embodies a number of other improvements of interest. The connecting-rod to the cross feed has a friction slip joint by means of which it automatically adjusts itself to the correct length when the table is raised and lowered. The friction joint also prevents breakage of the feed gears should the feed become blocked by accident or by the carelessness of the operator.

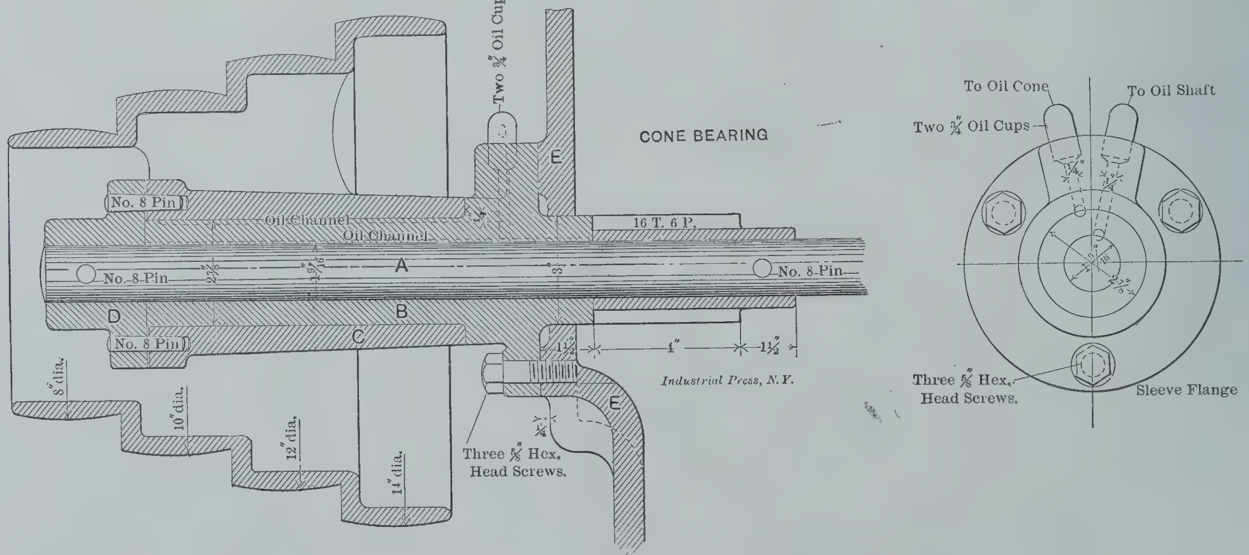


Fig. 1. Sleeve Support for Cones and Pulleys.

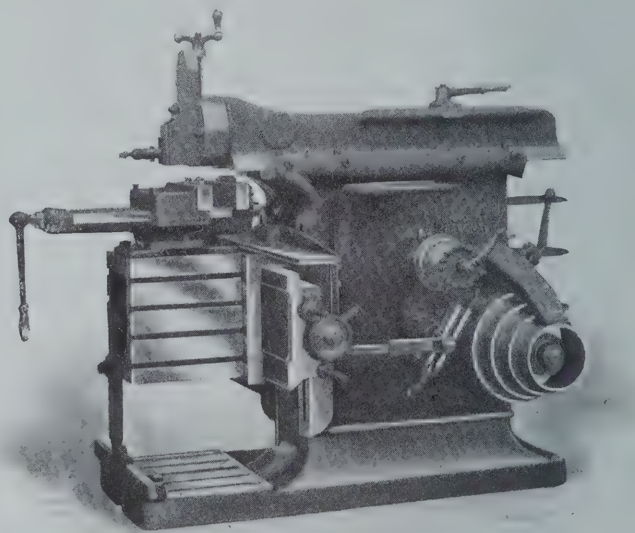


Fig. 2. Improved Gould & Eberhardt Shaper.

An arm projects over the cone, which bears numbers cast on the top corresponding to the different steps. These indicate the proper speeds for different lengths of stroke. All oil holes are provided with filter covers, which prevent the ingress of dirt, chips, etc., and filter all lubricant fed to the bearings. All the bearings are bushed where the wear is likely to become appreciable, so that all shafts may be readily brought back to their original centers. The other features, such as striking place on vise, stiffened ram, vertical graduations on vise, etc., which distinguish this tool, have been described before.

Brown & Sharpe Mfg. Co.

Providence, Rhode Island, U. S. A.

* * *

RULES

That are the Recognized Standards for Accuracy.

Those stamped "B. & S. Mfg. Co." are the result of more than fifty years' experience in the manufacture of Rules.

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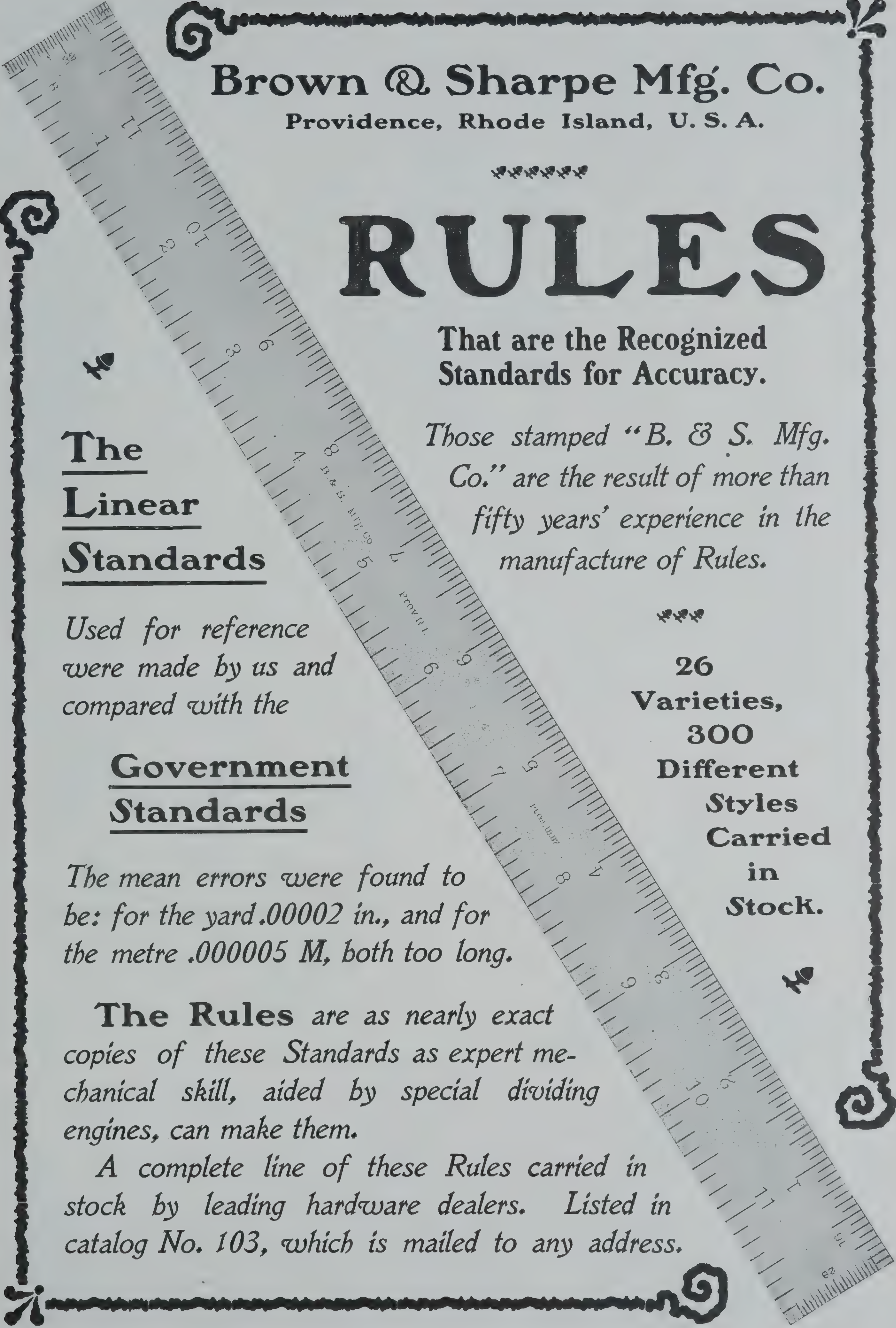
26 Varieties, 300 Different Styles Carried in Stock.



The Linear Standards

Used for reference were made by us and compared with the

Government Standards

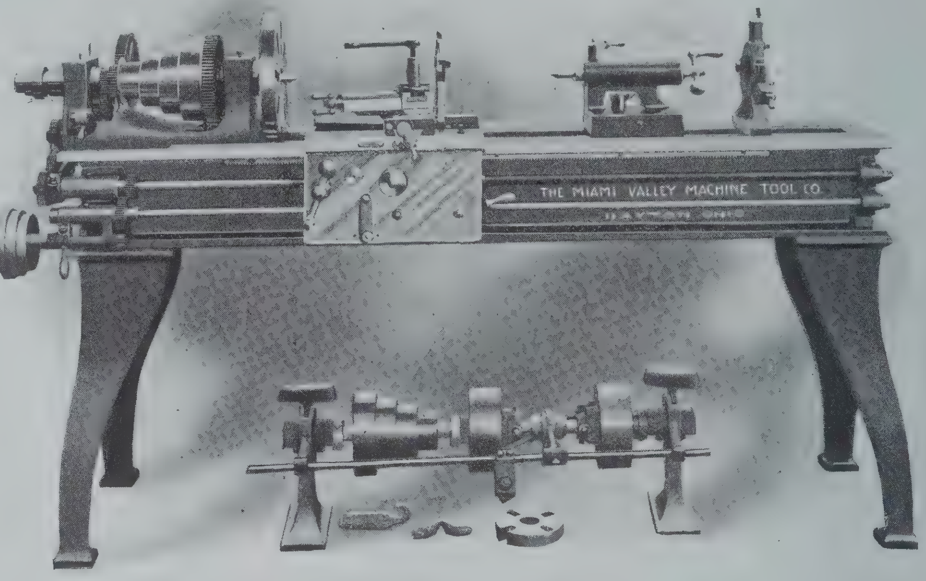
The mean errors were found to be: for the yard .00002 in., and for the metre .000005 M, both too long.

The Rules *are as nearly exact copies of these Standards as expert mechanical skill, aided by special dividing engines, can make them.*

A complete line of these Rules carried in stock by leading hardware dealers. Listed in catalog No. 103, which is mailed to any address.

NEW 13 1-2 INCH LATHE.

A new 13½-inch lathe is shown in the illustration, manufactured by the Miami Valley Machine Tool Co., Dayton, O., for whom the Patterson Tool & Supply Co., Dayton, are the selling agents. No novel features have been introduced in the design, the main considerations having been to produce a lathe with parts of ample proportions, convenient to operate, and durable and accurate in construction. The spindle is of high-grade steel, with ground journals and phosphor-bronze boxes. The cross feed is graduated. The chasing stop is always with the lathe, and it is impossible to throw in rod and screw feeds at the same time. The feed cone is provided with a swinging tightener. The centers are large, with no bushing in the spindle, but a safety plug is provided to avoid accident when the center is removed. The tailstock is of the overhanging style, with set-over. The feeds in head and apron are reversible. The head and tailstocks are fitted to the bed with a V at the rear and flat bearing in front, permitting the cross-bridge of carriage to be heavy and rigid. Besides the belt and rod-feed, a positive-feed can be obtained by engaging gear on leadscrew to the feed-rod. The carriage is provided with lock-screw. It has V-bearing in front and flat bearing in rear, and is gibbed. All sliding bearings on the V's are fitted to completely cover them, and avoid wearing a ridge in them. The power cross-feed is thrown in and out by moving a button. The countershaft has double-friction pulleys, simple in construction and easy of adjustment. Care has been taken to insure perfect facilities for oiling all bearings, especially in the apron. The compound rest is graduated in degrees.

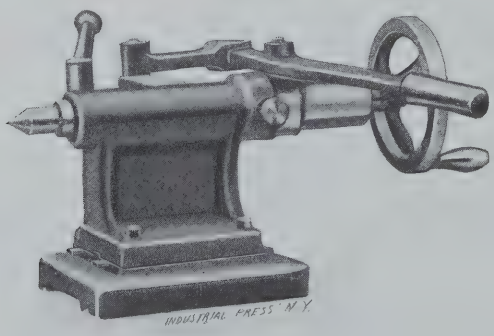


Thirteen and One-half Inch Engine Lathe.

The front bearing of the spindle is 2 inches diameter, 3¾ inches long; the rear bearing of spindle, 1⅝ inches diameter and 3 inches long, and the hole through the spindle 1 1-16 inch. The diameters of the head-cone pulley are 3½, 5, 6½ and 8 inches. The ratio of the back gearing, 9.1 to 1. The lathe cuts threads 4 to 64, including 11½.

IMPROVED TAILSTOCK FOR LATHES.

The accompanying illustration is of a tailstock which J. G. Blount & Co., Everett, Mass., are applying to a new line of speed lathes. The tailstock has a combination wheel and lever feed and when required the lever can be readily applied by dropping it over two pins, one of which serves as a fulcrum and the other for moving the tailstock slide. Then by releasing two thumbscrews at the sides the slide is released so that it can be moved by the lever. Another important feature is the arrangement for adjusting it up or down by means of the two wedges seen in the illustration projecting between the body and base of the tailstock. These wedges can be pushed either way by tapping with a hammer, bringing the dead center accurately in line with the live center of the lathe, after which the two parts are locked securely together by means of cap screws. The tongue cast in the center of the base, which appears in the illustration, fits a dovetail groove in the base of the tailstock and keeps it accurately in line sidewise.


INDUSTRIAL PRESS N.Y.

Tailstock with Special Adjusting Device.

THE "CHICAGO" COUNTERSHAFT.

A very simple and compact countershaft of novel design, called the "Chicago Pullet," has recently been brought out by Hill, Clarke & Co., Chicago. It is thrown in or out by merely a pull on the cord attached to a weighted lever which is set on a pivot with just enough eccentricity to throw in the friction disk driving the main pulley or cone. The weight is proportioned to hold the friction well in place, without undue pressure, and the contact roller is made of sufficient size so that it runs comparatively slow. It does not run when the clutch is out. Allowance is made for taking up any wear, so that the weighted lever will act at the best angle and give the proper throw to the eccentric.

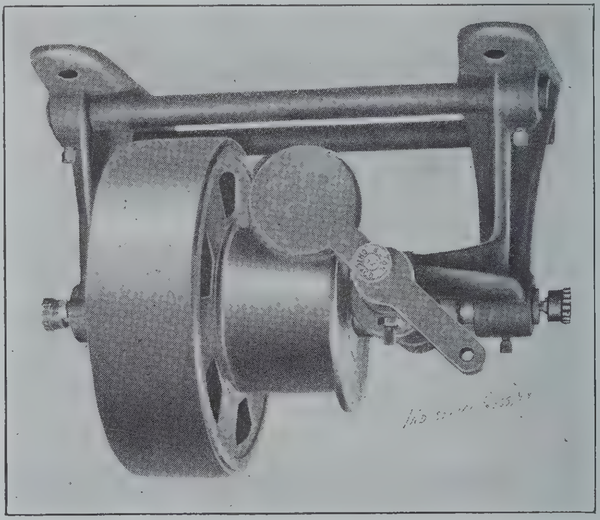
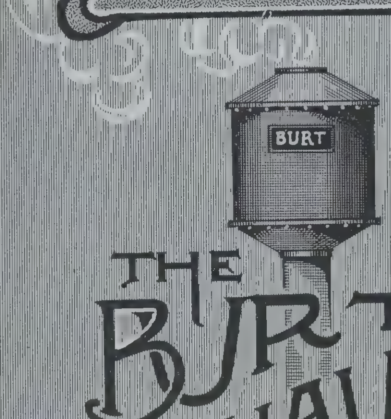


Fig. 1. Countershaft which is both Started and Stopped by Pulling an Attached Cord.

The shaft is stationary in the hanger and the pulleys revolve upon it, thus giving them a long bearing. The shaft is drilled longitudinally from both ends and grooved to distribute the lubrication, which is effected by grease cups. The contact roller also revolves upon its shaft and is lubricated in like manner. In order to accommodate different settings and directions of drive, the frame is constructed to take the "throw-over" lever at either side. The method of mounting upon heavy pipe allows the countershaft some adjustment in setting up.

THE BURT MANUFACTURING Co.
AKRON, OHIO, U.S.A.



THE BURT EXHAUST HEAD

PREVENTS oil and wet steam from escaping out of the exhaust pipe.

PREVENTS drenching your own and your neighbors' roofs.

PREVENTS dripping to the sidewalk below and forming mud in the summer and ice in the winter.

PREVENTS damage to clothing, accidents to limb and the resulting suits at law.

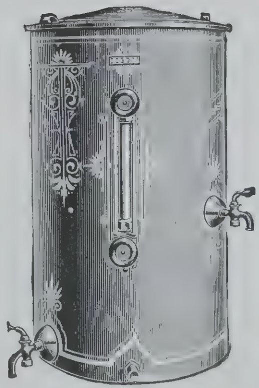
SAVES Steam, Water, Fuel, Heat, Roofs, Trouble, Accidents, Money.

Saving Waste Oil.

.... Do you not waste more oil than you use by throwing away that which has become blackened and filled with dirt and grit?

It Needs Washing

to remove these impurities, after which the oil may be used over and over again until every particle is consumed in lubricating the machinery on which it is used.

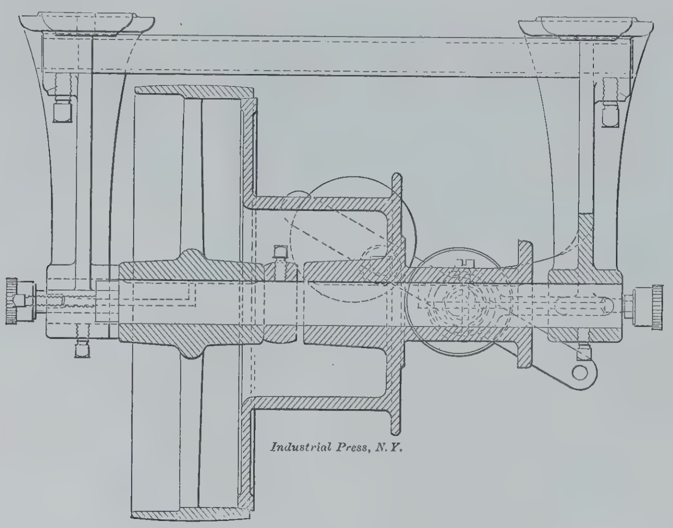


THE WARDEN OIL FILTER

is designed to purify this oil, to literally WASH IT free from all impurities. Dirty black oil, full of chips, is poured into the filter and clean new oil drawn off from the cock on the side. This filter consumes no power, requires no attention, needs no chemicals, runs day and night, asks for no time off, and never watches the clock! It is made in all sizes from 15 gallons to 300 gallons a day and will be shipped on trial at our expense.

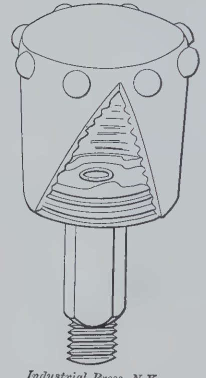
MACHINERY-NEW YORK.

This construction also allows the use either of a single driving pulley or a cone pulley of several steps, as preferred, since the countershaft does not require a shifting belt. Further particulars regarding the countershaft will be furnished by Hill, Clarke & Company, at Chicago, Boston or New York.



Details of Countershaft.

NEW GREASE CUP.



Grease Cup for Automobiles.

Now that automobiles have become a staple product in the market there are a great many fittings of various kinds manufactured expressly for use on automobiles. Among these are oil cups of various descriptions, of which one was shown in a recent number of this paper. In the illustration herewith is shown a grease cup for automobile use, made by Chas. H. Besly & Co., Chicago, Ill. It is of a design similar to that of their standard Badger grease cup, but is of double the depth and the stem is made proportionately longer. The cup is of cast iron, and the stem of bar steel drilled and threaded, so there is no danger of its breaking off. The internal thread of the cup is a round thread which will not strip, clog or cross. The round projections at the top of the cup enable one to secure a firm grip for unscrewing, and also make it possible to attach a wrench if found necessary.

* * *

FRESH FROM THE PRESS.

L. L. Cline, founder of the Trade Paper Advertising Agency, Hodges Bldg., Detroit, Mich., is now issuing a quarterly publication entitled "The Trade Press," a copy of which has reached us. This journal is to be devoted especially to the writing of advertising matter for mechanical papers and others.

Arithmetic of Electrical Measurements, by W. R. P. Hopps, and revised by Dr. Richard Wormell. Published in England and for sale by D. Van Nostrand, 23 Murray St., New York. 112 pages, 12-mo. Price 50 cents.

The chapters of the book take up joint resistances, division of current in branch circuits, strength of current with cells in parallel, in series and in opposition, electromotive force, battery power, best arrangement of cells, resistance of conductors, electric lighting, etc. The book has proved useful to students who are learning to make electrical calculations and wish to have a convenient collection of formulas and examples for practice.

Self-Propelled Vehicles, by James E. Homans, A. M. Published by Theo. Audel & Co., 63 5th Ave., New York. 632 8-vo. pages, with nearly 500 engravings. Price $5.00.

This book contains a collection of notes, data and descriptive matter relative to the various types of steam, gasoline and electrical motor carriages. The book is non-technical in character and is intended for the general reader interested in the subject of automobiles. Such a person will here find a great mass of matter, largely descriptive, reviewing the present state of automobile construction. Certain technical points are explained in a way to be understood by the general reader, such, for instance, as differential equalizing gears, different types of steering gear and the operative principles of steam, gasoline and electric types of carriage. The illustrations are largely reproduced from catalogues or articles that have appeared elsewhere, although many have been made expressly for this work, and while not so attractive as newly made cuts, are sufficiently clear and numerous to serve the purpose of supplementing the text. The author has evidently touched upon the most important subject pertaining to automobiles, and gives chapters upon the boilers, including flash boilers, boiler feeding, burners, carburetters, vaporizers, etc. The parts of the carriage itself are also taken up and there are chapters upon motor carriage wheels, springs, ball and roller bearings, brakes, etc. The explosive engine receives rather more attention than any other subject. Taken altogether it is probably the most complete American treatise on automobiles and will give one a very full and correct impression of current automobile practice.

Water-tube Boilers, by Leslie S. Robertson. Printed in England and for sale in America by the D. Van Nostrand Co., 23 Murray St. and 27 Warren St., New York. 213 8-vo. pages, illustrated. Price $3.00.

This book is devoted entirely to water-tube boilers of both American and foreign types, and the text is mainly descriptive, there being little mathematical work. It is really a collection of illustrations pertaining to the most prominent types of water-tube boilers. It traces the history of water-tube boilers, showing some of the earlier forms, and discusses modern types for stationary purposes, and contains descriptions of a number of launch boilers and marine boilers for larger vessels. The book is made up from a series of lectures upon water-tube boilers delivered by the author at University College, London.

The Prevention of Smoke combined with Economical Combustion of Fuel, by W. C. Popplewell. 203 pages and 46 illustrations. Published by Scott, Greenwood & Co., London, and D. Van Nostrand Co., New York. Price $3.50 net.

The prevention of smoke in cities and towns is always an important subject, but at the present time it is of unusual interest in great cities like New York on account of the great anthracite coal strike. New York, because of its closeness to the anthracite regions of Pennsylvania, has always used anthracite coal in preference to bituminous coal, as it is usually as cheap for the steam sizes. Consequently New York has enjoyed the reputation of being the cleanest city in the world, not so much, perhaps, because of the strenuous efforts of its officials to make it so, but because of the cheapness of hard coal. Now that the coal strike has made it impossible to get anthracite coal New York is using soft coal, with the consequence that many of its chimneys are pouring forth volumes of black smoke in a manner that rivals those of Pittsburg and of Western cities. The plants that are fortunate enough to be equipped with automatic stokers are enabled to burn the unusual fuel without serious difficulties in preventing smoke. When it is considered that property is more valuable, the death rate is lower, the moral conditions are better, the damage to fine fabrics less and conditions to a high standard of living far more favorable where smoke and carbon deposits are not known, the prevention of smoke at once becomes a subject of the greatest importance.

The book in review treats of the smoke problem as found in England. It is shown that the difficulty there is much more serious than here, as soft coal is used for almost all domestic fires. In London the volume of smoke poured out daily by these fires is probably equal to if not greater than that emitted by the chimneys of manufacturing establishments. The problem is therefore a much more serious one to combat than here where manufacturing establishments are the chief offenders. Yet the conditions are not considered hopeless and means and ways are pointed out that if adopted generally would materially abate the evil. Various forms of grates and furnaces for house use are described briefly. Chapter I. treats of fuels and combustion, chemical action, quantity of air required for perfect combustion, formation of smoke, effect of air supply on the formation of smoke. The following chapter discusses hand firing and describes forms of furnaces designed for smokeless hand firing. Then follow descriptions of various mechanical stokers, powdered fuel firing, gaseous fuel and the means of producing it, smoke observations, standard smoke tests, etc.

ADVERTISING LITERATURE.

The Sterling Emery Wheel Co., Tiffin, O. Illustrated catalogue of emery wheels, grinding and polishing machinery and supplies.

The Buffalo Forge Co., Buffalo, N. Y. Illustrated pamphlet treating of the Buffalo improved ventilators, Buffalo blowers and exhausters, etc.

Manning, Maxwell & Moore, New York. Circular No. 9, of second-hand machine tools. This circular will be sent to anyone upon application.

The American Blower Co., Detroit, Mich. Catalogue No. 141 of the A. B. C. pressure and volume blowers. The company's products are fully described and illustrated and price lists are also given.

The Massachusetts Tool Co., Greenfield Mass. Catalogue No. 3 of fine precision tools, including micrometer calipers, micrometer gages, surface face gages, steel rules, center squares, depth gages, dividers, etc.

The L. S. Starrett Co., Athol, Mass. Supplement to catalogue No. 16 of fine mechanical tools. This pamphlet illustrates the tools manufactured and calls attention to some new sizes of squares and calipers now being made by the company.

The Standard Tool Co., Cleveland, O. Catalogue of twist drills, reamer chucks, spring cotters, taps, flat spring and riveted keys, milling cutters and special tools. This catalogue is very complete and will prove interesting to the prospective purchaser.

The Norton Grinding Co., Worcester, Mass. Illustrated catalogue 6 x 9 of the Norton plain grinding machines. The catalogue also contains specifications of the 12-inch x 72-inch plain grinding machine described in our August issue.

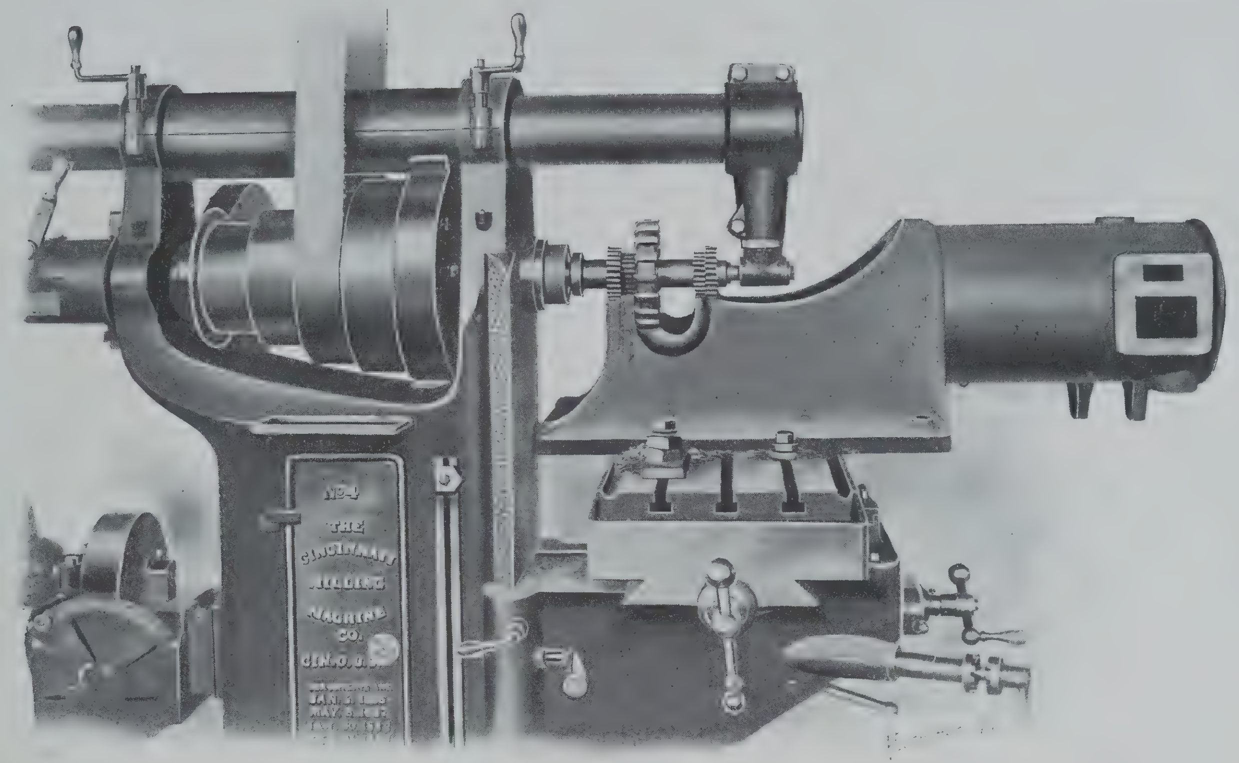
The Skinner Chuck Co., New Britain, Conn. 1902 catalogue and supplement of the Skinner patent chucks. These include lathe, drill and planer chucks and faceplate jaws. The company are also prepared to make special chucks to order. The catalogue contains a large number of cuts of chucks and also a price list.

The Bignall & Keeler Mfg. Co., Edwardsville, Ill. Standard size catalogue of pipe-threading and cutting-off machinery. The various styles and sizes of these machines are illustrated by excellent halftones and the machine parts are described in detail. These machines are built to operate by hand or by power.

The Garvin Machine Co., Spring & Varick Sts., New York. Illustrated catalogue No. 8 of screw machines, monitor lathes, forming machines and double turret screw machines. This is one of a series of 14 catalogues issued by this company dealing with the machinery manufactured and handled by them.

The American Tool Works Co., Cincinnati, O. Circular calling attention to some of the lathes manufactured by this company, and containing letters received from purchasers of "American" lathes expressing their satisfaction therewith. The company issue a "Lathe Book" which gives full details of their lathes and which may be had upon application.

The R. K. LeBlond Machine Tool Co., 4620 Eastern Ave., Cincinnati, O. 1902 illustrated catalogue of engine lathes. These range in size from 10 to 30 inches. The LeBlond engine lathe with interchangeable turret on the carriage is described and illustrated, and turret lathes, roughing lathes, stud lathes, bed lathes, etc., are also shown.



Just twenty-eight minutes

are required for machining the bearings in an 8 H-P. engine frame in the shops of The Root & VanDervoort Engineering Co. when the work is done on a No. 4 Plain Cincinnati "Geared-Feed" Miller. The best time they ever made on a planer was 1 hour and 35 minutes. The time in each case, includes handling and chucking the work. The miller saves more than 70 per cent. of the best planer time. Through the light part of the cut, i. e. when the cutter enters and leaves the work the machine is fed .102 in. per turn, and through the heavy part of the cut the feed is .080 in. per turn. The change from the fast to the slow feed and then back to the fast feed again is made by simply shifting a lever and is done by the operator while the cut is going through. The space traversed in entering and leaving the cut about equals the length of the heavy part of the cut. That means that for one-half of the entire table travel the work is being done 27 1-2 per cent. faster than would be possible on a miller requiring the manipulation of change gears or transposing cone pulleys and belts, to secure the feed changes. This illustrates one of the points we have in mind when we talk about the advantages of a "quick feed changing device" on our miller. Will be glad to take up other points with those interested.

Our 1902 Catalog tells some things worth knowing and can be had for the asking. We will show you another way to mill at a money-saving rate next month.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENES—Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg, Brussels, Stockholm and New York. Adolph Janssens, Paris. Chas. Churchill & Co., London, Birmingham, Manchester, New-Castle-on-Tyne and Glasgow. The Niles Tool Works Co., 23-25 Victoria St., London, S. W.

MONTGOMERY & Co., 105 Fulton St., New York. Catalogue No. 21, entitled the "Tool Catalogue." This treats very completely of the large line of small tools, factory supplies and light machinery carried by this company. The catalogue contains 704 pages and is very profusely illustrated. A complete index is given, and the catalogue will be most valuable to anyone interested in this line of goods. The pamphlet entitled "Confidential Prices," accompanying catalogue No. 21, gives the discount on all the articles manufactured.

THE RAND DRILL Co., 128 Broadway, New York, have issued a timely pamphlet showing the progress of the work on the New York rapid transit subway. The book is designed primarily to advertise the fact that the Rand air compressors and compressed air drills are used extensively by the different contractors in excavating for the tunnel. In addition to a general description of the tunnel and of the work so far accomplished, there is a brief review of the various attempts at rapid transit in New York City, including the surface and elevated roads, as well as the attempts to start the great underground system. The illustrations are mainly from photographs.

THE FOSDICK MACHINE TOOL Co., Cincinnati, O. June, 1902, catalogue, standard size, of the radial drills and drilling machinery manufactured by this company. This is a handsome catalogue, containing many fine half-tone illustrations of the various sizes and styles of the company's drills, together with complete descriptions of same. There is also a half-tone showing the company's works and one giving a view of a part of the shop where the radials are built. Space is also given to a large number of copies of letters from different firms expressing their approval of these radials. Catalogue will be forwarded when applied for.

MANUFACTURERS' NOTES.

PAWLING & HARNISCHFEGER, Milwaukee, Wis., send us a statement of orders received from 15 well-known firms in this country for cranes and hoists of their manufacture.

THE BURT MFG. Co., Akron, O., have received an order from the Detroit Copper Mining Co., Morenci, Ariz., one of the largest copper mines in the world, for two 50-gallon Cross Oil Filters, making ten of these filters in use in their mines.

THE CLEVELAND PNEUMATIC TOOL Co., Cleveland, O., have recently opened up an office at 411 Park Bldg., Pittsburg, Pa., represented by Chas. L. Nelson, and at 34 Lemoine St., Montreal, Canada, represented by N. J. Holden.

THE COLBURN MACHINE TOOL Co., Franklin, Pa., manufacturers of high-grade machine tools, state that work on their new plant is progressing very nicely and they are getting in their equipment and shall have their machinery installed and works in full operation in from about thirty to sixty days.

THE U. BAIRD MACHINERY Co., Pittsburg, Pa., has been incorporated under the laws of the State of Pennsylvania, the new name of the company being the Baird Machinery Co. The officers are Messrs. C. A. Wolfe, H. A. Reed, W. B. Wolfe, O. P. Meckel and J. L. McCartney.

THE NEWTON MACHINE TOOL WORKS, 24th and Vine Streets, Philadelphia, will shortly issue a new catalogue 6 x 9 consisting of about 250 pages. The company would be pleased to have the addresses of all those desiring a copy and all requests will be carefully attended to.

THE BUFFALO FORGE Co., Buffalo, N. Y., state that their products are in steady demand not only in the United States, but also in European countries. They send us a list of 16 orders received through their different branch houses for steel plate steam fans, direct-connected Buffalo engines, etc.

THE CLEVELAND PNEUMATIC TOOL Co., Cleveland, O., inform us that the contracts for their new plant have been awarded to Messrs. J. A. Reaugh & Son, of Cleveland, O. It is expected to have the plant completed and ready for operation within 90 days. The plant will be equipped with the most modern machinery and appliances for turning out the largest amount of work in the shortest time.

THE AUTOMOBILE & CYCLE PARTS Co., Cleveland, O., since August 1st have transacted and will continue hereafter to transact their business under the name of the Federal Mfg. Co. This change of title will not affect the management of the company or the business of their factories. The company inform us that their products are so diverse that a comprehensive name became a necessity.

GEORGE WILLIAM HOFFMAN, 295 E. Washington St., Indianapolis, Ind., sole manufacturer of the "U. S." metal polish and "Bar Keeper's Friend" and other specialties, sends us a circular treating of these specialties. This polish may be had in powdered or liquid form, as desired, and is used to remove stains, grease, smut and tarnishings from plated or polished metal, marble, porcelain, glass, wood, etc.

THE BUFFALO FORGE Co., Buffalo, N. Y., have been awarded the contract for the installation in the mines of the Continental Coal Co., Glouster, O., of three 250-inch fans for the purpose of ventilating and exhausting fumes, smoke and dangerous gases. This plant is similar in many respects to that of the Modoc Coal Mining Co., located at the same place and recently installed by the Buffalo Company.

THE FALKENAU-SINCLAIR MACHINE Co. is a new company organized for the manufacture of machine tools and located at 109-115 North 22nd St., Philadelphia. This company has taken over the entire plants and business interests of A. Falkenau and of the Philadelphia Machine Tool Co. Besides the building of machine tools and special machines, and contracting for machines in large quantities, the company's full lines of presses and machines for working sheet metals, hydraulic machinery and testing machines will be continued and extended.

THE ROYERSFORD FOUNDRY & MACHINE Co., Royersford, Pa., report a very active business in the sale of their punch and shears. Several of their machines have just recently been shipped to Manning, Maxwell & Moore, New York, N. Y., and a carload to the Marshall & Huschart Machinery Co., Chicago, Ill. They have made the Marshall & Huschart Machinery Co., 62-64 So. Canal St., Chicago, Ill., their exclusive agents for the sale of their machines in the States of Illinois, Indiana, Michigan, Wisconsin and Ohio, the city of Cleveland excepted.

THE PHILADELPHIA PNEUMATIC TOOL Co., Philadelphia, Pa., report an unprecedented rush of business, their manufacturing capacity being taxed to the utmost to keep up with orders. The increasing demand for the Keller rotary drills is particularly noticeable. They state that four of the large eastern steel companies have recently purchased Keller tools to the aggregate number of 237. One of the western trunk line railroads has recently made a contract with this company to purchase at least 1,500 Keller tools within the next eight months, and a cable order for Keller tools was received last week from Bilbao, amounting to several thousand dollars.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., has recently made an arrangement whereby the students are admitted to the classes of one of the prominent technical schools without further examination, and their work counts toward a degree of B. S. Ambitious young men who cannot afford to give four years to study for a college degree can now do part of this work at home and finish at a resident technical school. The Trustees of the American School have been offering a limited number of free scholarships; after September 30th the offer will be withdrawn. There is still an opportunity, therefore, to obtain, free, a course in mechanical, steam, textile and sanitary engineering and mechanical drawing.

PAWLING & HARNISCHFEGER, Milwaukee, Wis., makers of electric cranes and hoists, have just acquired the Gardiner Campbell Co.. property adjoining their works. This property is 200 by 150 feet., and the three-story building is being remodeled to supply additional machine shop facilities, and to provide extra pattern storage. The foundry is being changed over, and added to. In the entire building will be placed a modern foundry equipment. Among the improvements will be two P. & H. electric traveling cranes. Their present power plant is also being enlarged and new boilers, engines and another generator will be provided. They state that these improvements will considerably shorten the time required to complete a crane or hoist.

IN the editorial columns of the engineering edition of MACHINERY for this month reference is made to the fact that the Standard Welding Co., Cleveland, O., are now turning out electrically-welded parts for automobile construction. They write us that they are also enlarging their plant by the erection of new buildings to enable them to increase their stock of manufactured tubing in sizes from 2½ inches diameter and smaller. This tubing is uniform in gage, of the best open-hearth steel and is particularly adapted to places where the tubes are to be plated with nickel or other similar finish. The company also wish to announce that they are prepared to contract for various classes of work. They will either electrically weld stampings and forgings furnished them by manufacturers, or will do the whole work complete.

THE NEW PROCESS RAW HIDE Co., Syracuse, N. Y., have recently made arrangements with Messrs. Geo. Angus & Co.. Ltd., Newcastle-on-Tyne, England, prominent manufacturers of leather, whereby the English concern is to establish a plant in England for the manufacture of rawhide gears and other products under the patents and secret processes of the New Process Raw Hide Co., using the latter company's trade mark. This plant it is expected will take care of the company's business not only in Great Britain, but throughout Europe, Messrs. Angus & Co., having offices in nearly all of the principal cities. The English company will shortly place orders with American firms for the latest gear-making machinery and will proceed at once with the fitting out of the new factory which will be located at Newcastle-on-Tyne.

THE DERRY COLLARD Co., with offices at 256 Broadway, New York City, has been organized for the purpose of publishing and selling educational books, charts, models, etc., for readers of technical literature. One of the first books to be brought out will be a treatise on hardening, tempering and annealing steel, by our contributor, Edw. R. Markham, the consulting expert. A locomotive valve model will also soon be ready. A new policy has been adopted by this company for the sale of technical books, in that they will send books to any person for examination before he pays for them. If he finds them satisfactory he can then remit, and if not, the books can be returned. Detailed information will also be furnished about the technical merits of any book, whoever the publisher, either by circular or by written letter. The office of the Derry Collard Co. is fitted as a reading room and any mechanics visiting New York will be welcome there. The president of the company is Mr. Fred. H. Colvin, who was formerly editor of MACHINERY.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line.

The money should be sent with the order.

A MANUFACTURING CONCERN in Northern Ohio thoroughly equipped with entirely new plant for turning out light or medium weight tools of any character suitable for machine shop trade, would like to correspond with parties desiring same manufactured on royalty. Address MANUFACTURER, 9-15 Murray St., New York.

AGENCY WANTED for high-class engineers' and woodworkers' tools by thorough engineer with own workshop. Power in showroom. Good connections in England. Established in 1876. W. ROBERTSON, Engineer, Eccles, near Manchester, Eng.

FOR SALE CHEAP.—Two colored charts, A. and B., for scientific tool tempering, explaining tempering in oil, water and tallow and telling what each tool will stand. Also, 40 new steel working methods for forging and welding different kinds of steel and five of the best steel welding compound receipts on earth. All new and up-to-date. Send for free samples. The two charts and the 40 new methods for $1.00. Address W. M. TOY, Sidney, O.

INVENTOR'S MODELS built and perfected, special machinery designed and built, small parts duplicated. Let us quote prices. F. J. STOKES MACHINE CO., Philadelphia, Pa.; New York representative, FRANK P. WISNER, 46 Cliff St.

MANHATTAN TYPEWRITER FOR SALE—Same size and keyboard as Remington No. 2. Used about two years and in good running order. Price $25. Address INDUSTRIAL PRESS, 15 Murray St., New York.

SPECIAL TOOLS, models, fine light machinery and foundry work wanted. MURRAY MFG. CO., Richmond Valley, Staten Island, N. Y.

TO EXPORTERS OF MACHINERY TO RUSSIA.—The Toula Manufacturing Company, Limited, at Toula, in Central Russia, beg to inform American makers and engineers, who might be desirous of having their products manufactured in Russia itself, that they are prepared to undertake any orders that might be intrusted to them. The Toula factories include a cast-iron and steel foundry and newly fitted-up works with all the most modern appliances, including a large quantity of American machine tools, for constructing machinery of every description. The arrangement enables the company to undertake, under the most favorable conditions, the manufacture of all descriptions of machinery, machine tools, agricultural machines and specialties of all kinds. Address communications to: LES ATELIERS DE TOULA, SOCIETE ANONYME, 299 Chaussée d'Anvers, Brussels, Belgium.

WANTED.—Air Compressor, duplex 16 x 12, 110 revolutions, about 15 lbs. pressure, 610 cubic feet free air per minute. Address, H. SCHERER & CO., Detroit, Mich.

WANTED.—Engine Lathe manufacturer, or some other party with money, to take interest and furnish capital to patent an attachment every up-to-date engine lathe ought to have. Address E. W. W., care Machinery, 9-15 Murray St., New York.

WE DESIGN and make automatic machinery and special mechanical devices. Do all work in connection with the development of mechanical inventions. Engineering, designing, drafting, machine construction, models, tools, and also attend to job work and repairs. Address CHAS. E. HADLEY, Mechanical Engineer and Machinist, 584 Hudson St., New York, N. Y.

MACHINERY.

October, 1902.

SHOP CONSTRUCTION.—1.*

GENERAL PLANS FOR A MODEL PLANT.

Oscar E. Perrigo.

The "eternal fitness of things" requires that in whatever we design, build, equip and arrange for producing our portion of the product of the world's vast commerce, we shall strive to make it the best of its class; also, the best adapted for the special uses to which it will be put, the kind of goods to be manufactured, the circumstances, conditions and surroundings under which we work, etc.

In a great majority of cases the manufacturing plants of this country have been the result of *growth*, more or less rapid. Often they began with meager accommodations, which, as means allowed and necessity required, have been gradually added to. And thus the establishment became an aggregation of buildings of various sizes and forms, ofttimes representing in a general way the worst arrangement for economically producing work. At the same time it represented the total expenditure of a much greater amount of capital than would have been necessary to erect and equip good buildings, well suited to the practical necessities of the business.

There are numerous establishments in this progressive country to-day occupying antiquated and rambling structures that have cost money enough for the building of modern works properly designed for the economical production of a much higher grade of goods than it is possible to manufacture in old plants.

The world moves, and nowhere is this more apparent than in manufacturing. That which would answer the purposes of a business even five or ten years ago is among the "back numbers" to-day. The constant striving for the best was never more in evidence than at the present time among our up-to-date, progressive manufacturers, who are able to look beyond first cost to the greater advantages to be gained later on. The aim of this series is to discuss, from a practical standpoint, what is the best design, arrangement, equipment and management of manufacturing plants erected for the production of a medium-sized class of machinery, from the reception of the raw material to the shipping of the finished product. With this in view cuts showing the general plans for suitable buildings of a size and capacity for the usual work, arranged in compact form, of modern construction and supplied with conveniences for handling material and product, accompany this article. The entire plant, shown in Fig. 1, requires a site of somewhat less than 300 x 450 feet.

Fig. 2 shows a compact design to meet cases where the amount of land is limited and illustrates how all the buildings may be so grouped as to render the handling of materials and transportation of them as simple, direct and economical as possible. A railroad track should pass near the works, and from it a branch should be brought closely past the rear and to one side of the collection of buildings. Such an arrangement results in a great saving in the expense of hauling both material and product, and permitting the general arrangement and development of the plan herein proposed.

The main building, or machine shop, is 100 x 375 feet, divided lengthwise into a central portion 40 feet wide and 52 feet high, with side wings or bays each 30 feet wide. The central portion is open clear to the roof and has a traveling crane of ample capacity moving over its entire length. The side wings are divided into a main floor, on a level with the central portion and a gallery, or second floor; the first being 16 feet and the latter 14 feet high in the clear. This gallery is also built across 18 feet of the front end, thus connecting the two galleries and furnishing a platform by way of which the traveling crane may transfer material and product to and from the main floor. Along the center of these galleries and across the front end runs a tram track, provided with light push cars for facilitating the transfers. Stairways are provided at each end and in the center for conveniently and speedily reaching any part of the shop from floor to galleries and *vice versa*.

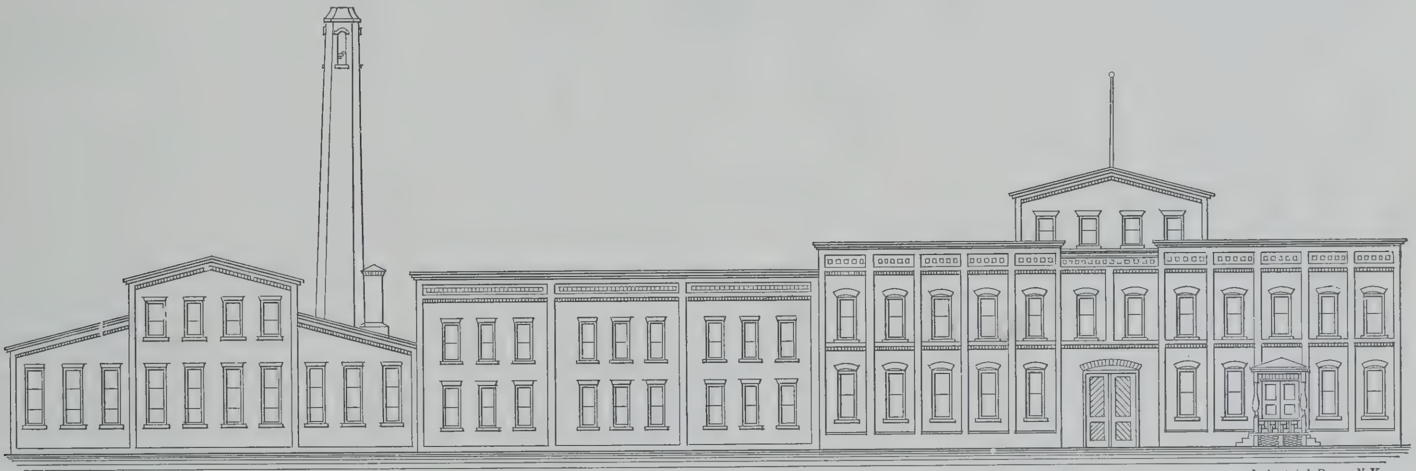

Industrial Press, N.Y.

Fig. 1. Front Elevation of Shops for a Model Plant to build Medium Sized Machinery. Scale, one inch equals forty feet.

At the front end of the machine shop proper are the offices connected with and forming a part of it, consisting of two structures 50 feet square, with a driveway space of 20 feet between them. On the first floor of one of these are the offices, storeroom, etc., and in the other the tool-making room, a room for storage tools and fixtures and a stock room for small finished parts. On the second floor is located the drawing room, while over the driveway is the pattern shop. The offices are only those particularly connected with the manufacturing and shipping, and not the general offices of the company. A wing connects the front buildings with the foundry. The ground floor of this wing is used as a storage room for pig and scrap

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* This is the first of a series of articles upon the design and construction of machine shops, treating of the various parts of a plant, from foundation to roof, and including hints upon the arrangement of tools and the management of the completed plant. The intention will be to give such information about the special requirements of machine shops as an architect, or structural engineer who has had no shop experience, usually does not possess.

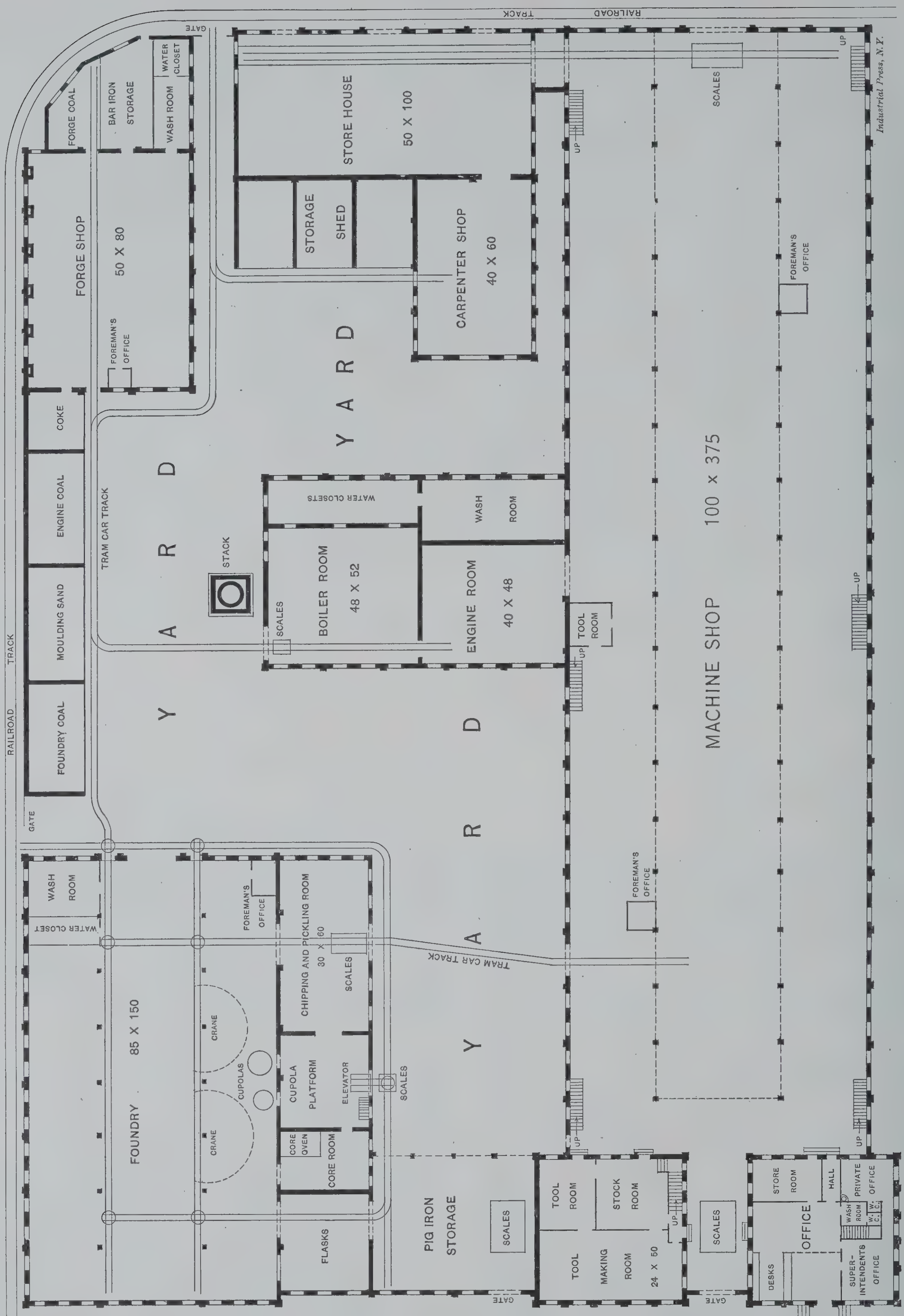


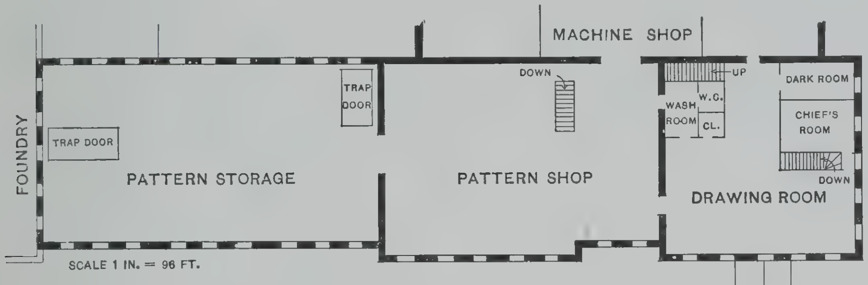
Fig. 2. Plan of Works shown in Elevation on the first page. Scale, one inch equals forty-eight feet.

iron, and a flask room, while the second floor is a pattern storage loft, connected at one end with the pattern shop and at the opposite end with the foundry by a trap door 8 x 18 feet, directly over the train track leading through the flask room.

The foundry is 85 x 150 feet, arranged with a central part 35 feet wide and two side wings or bays, each 25 feet wide. The central part is covered by a traveling crane running the entire length. There are two cupolas, a large and a small one, served by two cranes of sufficient reach to swing into the central space covered by the traveling crane. Large work is cast in the central space or within reach of the cranes, while small work and bench molding occupy parts of the floor not covered by the cranes. On each side of the central part are tram tracks, which are crossed by one running to the flask room and one that goes through the chipping room and on across the yard to the machine shop.

A wing built on the side of the foundry toward the machine shop contains a platform upon which coal and iron for charging the cupolas are delivered by a tram car raised to that level by an elevator arranged for the purpose. This stock is weighed on track scales in front of the elevator. Beneath the cupola platform are the tumbling barrels, convenient to the cupolas for working over the slag, and to the chipping room for cleaning small castings. The flask room is located at the front, while between it and the tumbling barrel space is the core room, containing a suitable core oven. At the opposite end, facing the yard, is the chipping and pickling room, where the castings brought in from the foundry are pickled, chipped and weighed, before being sent to the machine shop. If the castings are too heavy for convenient handling in the chipping room they may be run through to the yard and there handled by a boom crane covering the tram track upon which they are run into the machine shop. Castings of moderate size, yet too heavy to move by hand, are expeditiously handled by a light overhead trolley hoist in the chipping room. At one end of the outer wings are the wash room and toilet. If more floor space is needed these may be located in a gallery placed 8 or 10 feet above the foundry floor. In the further corner of the yard, as far as possible from the foundry and engine room, is the forge shop, 50 x 80 feet, which is reached by tram cars, the track running through its length near the center. On the outer walls are the chimneys for the forges and heaters, and in the rear are the storage shed for bar iron and steel, the wash room, toilet, and space for coal. These adjuncts are in a shed built with brick walls and of such outline as to conform somewhat to the curve of the railway track, the forge shop having been so located as to admit of this arrangement.

When down-draft forges, served by exhaust fans, are used, it will not be necessary to build more than one chimney, the flue of which should be large enough to carry off the smoke and gases from all the forges.



Industrial Press, N.Y.

Fig. 3. Plan of Second Floor in Foundry. Scale, one inch equals forty-eight feet.

The power house is located midway in the length of the machine shop, so that power may be applied to the line shafting at a point that prevents much of the torsion incident to long lines of shafting driven from one end. This building is 65 x 100 feet and contains the engine room, 40 x 48 feet; the boiler room, 48 x 52 feet, and also the wash room and water closets used by workmen in the machine shop. Near the boiler room is the chimney stack, with which the smoke flues of all the boilers are connected. Coal is brought in on push cars along the tram track, to the front of the boilers, where a track scale is placed for weighing it. Ashes are removed by the same tram track to whatever point is most desirable to deliver them. Across the rear end of the yard is the storehouse, 50 x 100 feet, for finished machines, or product. This connects with the rear end of the machine shop by a tram track running from the scales beneath the traveling crane through a wide doorway and the whole length of the storehouse. The rear side of the storehouse (next to the railway track) has wide, sliding doors, through which the finished product is readily moved into the railway cars for shipment. Here, as in the chipping room of the foundry, it may be desirable to make use of overhead trolley hoists to facilitate rapid and economical handling of machinery to be shipped. A 12-foot space is left between storehouse and forge shop for a branch of the tram tracks, as a convenient means of receiving material from the railway at this point.

Adjoining the storehouse is the carpenter shop, 40 x 60 feet. Thus the men who prepare the finished machinery for shipping are near their work, and the lumber used for this purpose, and the necessary machinery for cutting it up, are close at hand and require no unnecessary handling. In the angle formed by the storehouse and carpenter shop are the storage sheds for cast iron and steel chips from the machine shop, or for similar materials.

Along the side of the yard, and extending from the forge shop to within 20 feet of the foundry are arranged the stock sheds. These hold foundry sand and coal, engine coal, coke, etc., which is delivered into them directly from the railway cars, the track being raised to the proper grade after it has passed the storehouse. It is continued the whole length of the foundry so as to deliver foundry sand directly into the windows of the foundry if desirable, keeping that in the storage shed as a reserve supply. Between the storage sheds and foundry is a gate, through which may pass a branch of the tram car track for receiving stock and material from the railway cars at this point. Details of the plans herein outlined and the progress of the work from the raw materials to the finished product will be given in future articles. The second article will deal especially with the construction of the buildings.

Whatever may be the dimensions of the building of a manufacturing plant, or however carefully provision be made for all necessities for handling materials, etc., there is always the possibility, and frequently the probability, that some day the works will have to be increased in capacity or changed in form. It is, therefore, important to consider these points at the outset, and to provide for an expansion of the business in accordance with future needs and at the same time not to disarrange or break up the general plan of the works. With these points in mind, I give the two following plans for enlarging the machine shop when more room is needed: First, the building may be extended to the rear across the railway track, the rear wall being removed and the traveling crane tracks continued through the length of the additional building. Doors are provided for the passage of cars upon the railway track, and also a specially-built car habitually used for connecting the floors of the old and new building, its platform being on a level with the two floors. Thus the machine shop capacity could be increased to any reasonable extent. Second, one, two or three wings may be built at right angles to the machine shop and on the side opposite the power house. These might be of one or two stories and of any desired length. They may contain traveling cranes to convey material to and from the traveling crane of the main shop, or have convenient trolley hoists and train car tracks, according to the character of the work to be done.

The capacity of the foundry may be increased one-third by extending it toward the power house. The same space may be obtained by using for foundry space that provided for chipping, core and flask rooms and providing space for the latter by extending the building toward the machine shop. The space occupied by the wash room and water closet will, of course, be taken also and these rooms placed in a gallery, as heretofore suggested. To obtain additional power space for these enlargements the space occupied by the wash rooms and water closets may be utilized and these rooms provided for in an addition built toward the carpenter shop.

By some one of these plans, or a combination of them, the capacity of the works may be at least doubled without seriously disturbing the general plan here described and illustrated and without impairing the general efficiency of the facilities for handling the work.

This design is in as compact a form as is advisable, with a view to sufficient yard space. Where the amount of land is ample it would be manifestly desirable to spread out the design more by increasing the distance between the machine shop and foundry at the front, and the storehouse and forge shop at the rear; or by lengthening the machine shop 50 to 100 feet and thus add to the yard room.

Either or both these plans might be employed where the extent of ground would admit of it, as it is seldom we have too much yard room.

* * *

A so-called fluid lens has been invented by a Dr. Grun, of London, which has extreme rapidity. It is stated that it will produce excellent instantaneous photographs with artificial light such as might be had for example in a theater or other well lighted interiors.

THE LODGE & SHIPLEY DRAWING ROOM.

A WELL ARRANGED OFFICE HAVING NUMEROUS FEATURES OF INTEREST.

C. F. P.

The drawing room of the Lodge & Shipley Machine Tool Co., while small in comparison with those of many other large machine builders, has had much thought devoted to its equipment. This has been done with a view to securing facilities and conveniences that might assist the draftsman in full concentration of thought and energy upon the work in hand. Many improvements in drawing room equipment have recently been added and, as much interest has been manifested therein by visitors to the works, by special request I will endeavor to describe and illustrate some of them for the benefit of readers of MACHINERY.

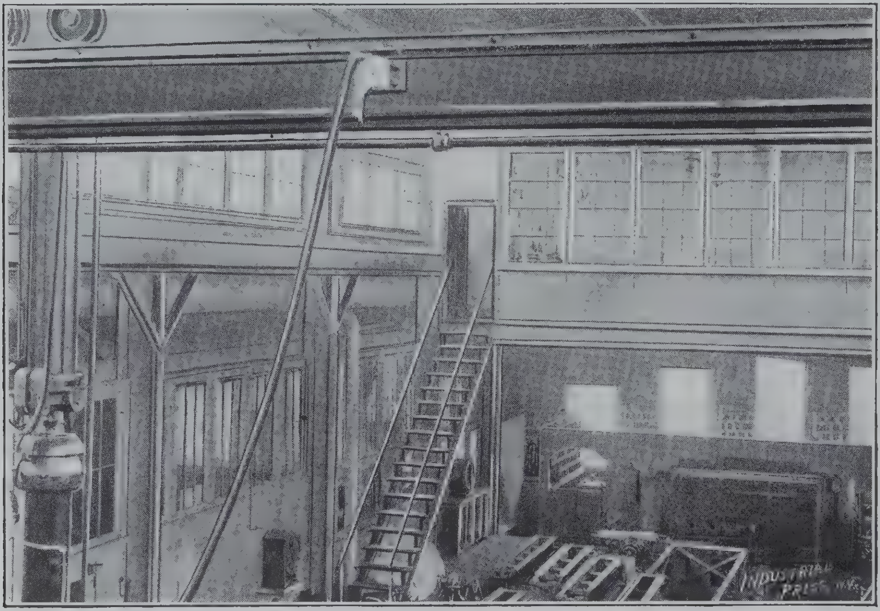


Fig. 1. View showing Location of Drawing Room at End of Shop.

Suitable quarters for the drawing room were not provided in the original plan of the building, and no room being available which would be convenient to the office and shop, it was decided to locate the necessary space 14 feet above the shop floor, at the office end of the building. This gives us a 15-foot ceiling in the drawing-room and a floor space of about 900 square feet, with light on all sides. Fig. 1 is an illustration showing the stairway to the drawing-room entrance and gives a fair idea of the location. Fig. 3 is an interior view of the northwest corner of the drawing-room, the vestibule landing of the stairway and entrance showing in the extreme left. In the center background of the illustration is shown the revolving blue-print rack, upon which is mounted a print of every standard, up-todate drawing of regular construction, indexed and arranged for the drawing-room force and shop foremen, for convenient reference. This rack, which is more clearly shown in Fig. 8, consists of 80 wings, each wing holding four 12 x 18-inch prints. The prints in the rack are so arranged as to bring together drawings of similar parts of all sizes. The details in the illustration are too small to be clearly seen, but it may be said in explanation that the rack stands open at "Reverse Plate" and shows the 18, 20, 22, and 24-inch prints; the 14 and 16-inch are on the reverse side of the left wing; the 27 and 30-inch on the reverse of the right wing, with the larger sizes following in the next wing in regular order. This system of mounting prints for reference is also used throughout the works.

In front of the rack is the card index cabinet, the upper unit of which is devoted to the indexing of all the drawings in the safe and file; all prints in the file and in the shop; all changes in regular construction; all material carried in stock, etc., etc., and is in a position easily accessible to the safe-and-file attendant and also to the drawing-room help. The lower unit faces the opposite way, and is, together with the base cabinet, devoted to the filing and card indexing of catalogues and printed matter intended for reference.

The safe shown in Fig. 3 contains 36 shallow drawers of galvanized iron, which are numbered and alphabetically labelled, an arrangement which allows the almost instantaneous locating of any drawing in the safe without reference to the card index. The fire-proof safe is used only for live drawings, and it is a rule of the room that all tracings be placed therein at night, thus insuring their safety in the event of fire.

The cabinet to the right of the safe consists of 150 shallow galvanized iron drawers, arranged the same as those in the safe, each drawing being numbered and labelled to indicate the contents. Fig. 7 shows the construction of these drawers more clearly and also the arrangement of labelling. The back of the drawer has an overlapping edge three inches wide which holds the sheets in position and prevents the back edges catching on the drawer above. No space is wasted, the drawer sliding in the grooved sides of the cabinet. The cabinet has a sliding door covering the entire front which when closed makes it dust-proof.

Fig. 4 shows the cabinet with door closed, and also gives an excellent idea of the arrangement of the tables to utilize the floor space to the best advantage. The tables in front of the windows, of which there are three, are for the use of the tracers, and each is fitted with a glass top for tracing, by transmitted light, either sun or artificial. This permits a tracing to be made even on heavy bristol board. Each draftsman is equipped with a drawing table, the construction of which is clearly shown in the several views of the room, and probably requires no further description.

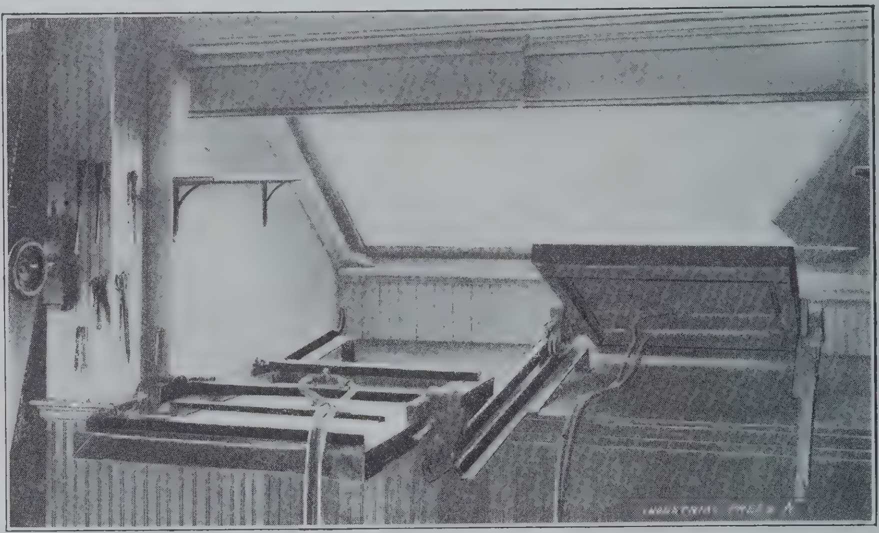
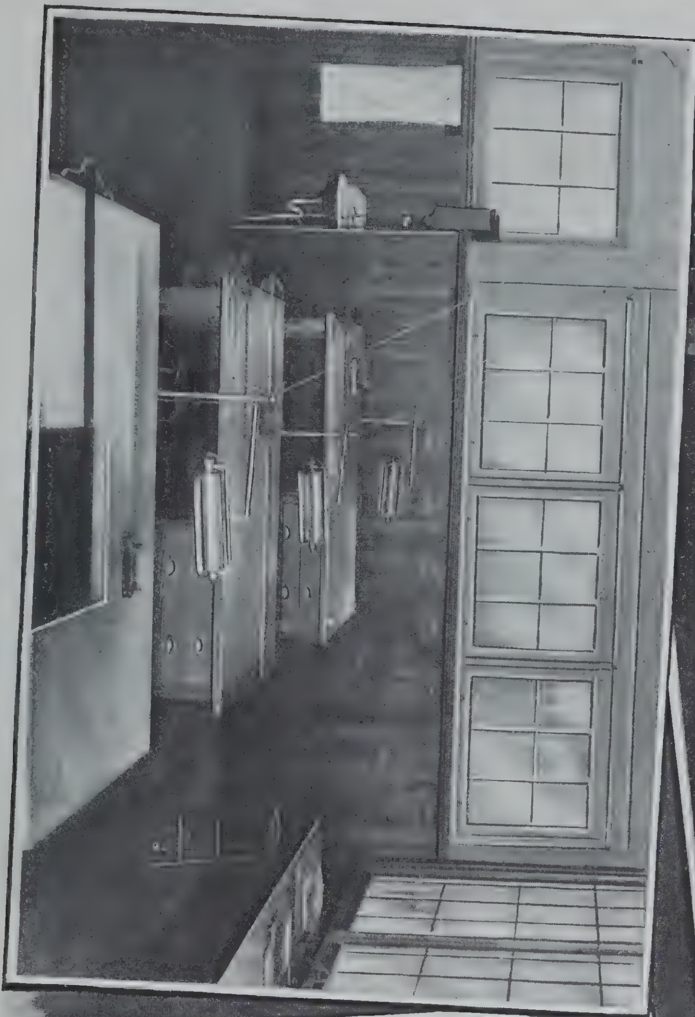


Fig. 2. Blueprint Frames and Window for Printing.

In Fig. 9 is shown in detail as well as complete the lamp we have made for use on the drawing tables. The vertical tube slips freely over the screw of C clamp; on this tube slides the cross carrying the horizontal telescoping tubes. At the outer end of the telescoping tubes is the elbow, in which swivels the T supporting the branches that carry the lamp and shade. The shade is of aluminum with wood and sheet brass ends. This arrangement allows placing the lamp in a way to get the full benefit of the light on any portion



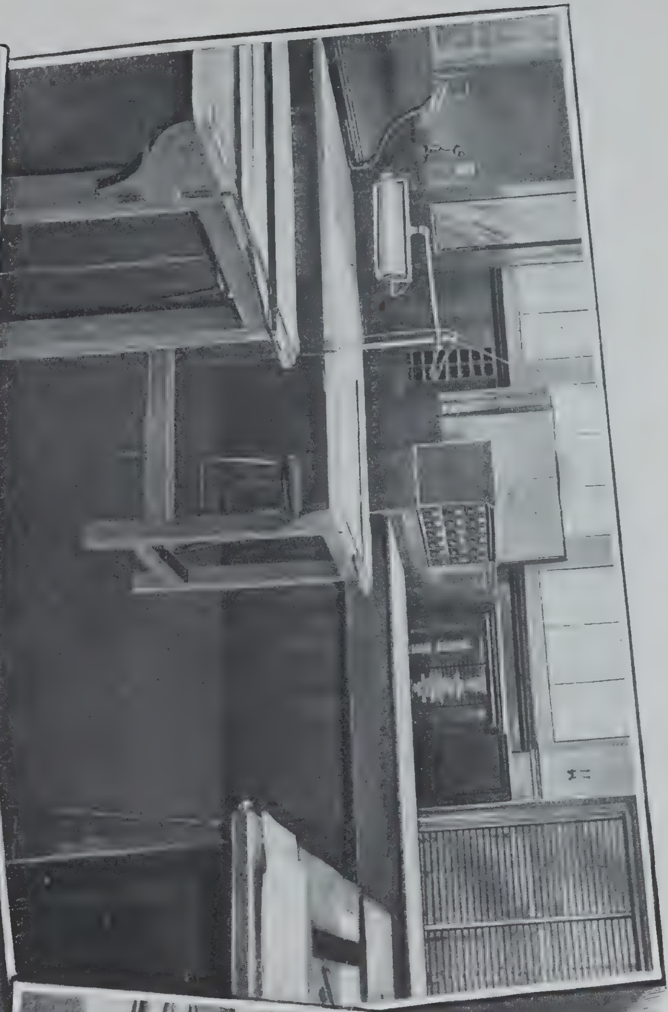
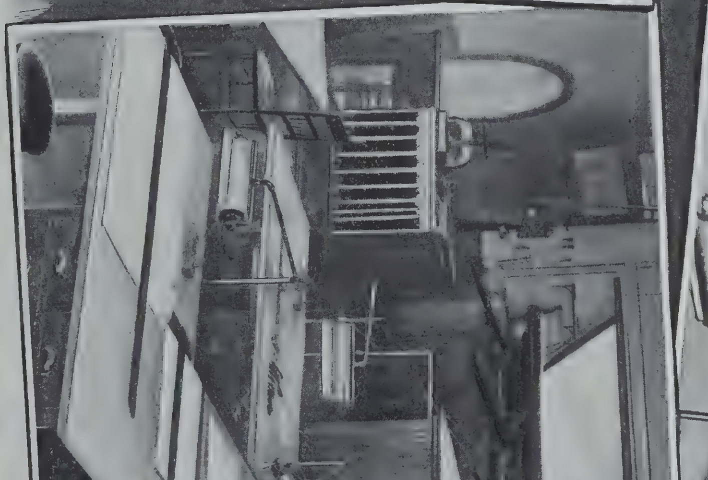


Fig. 3. Northwest corner of Drawing Room.
Fig. 5. Southwest corner of Drawing Room.



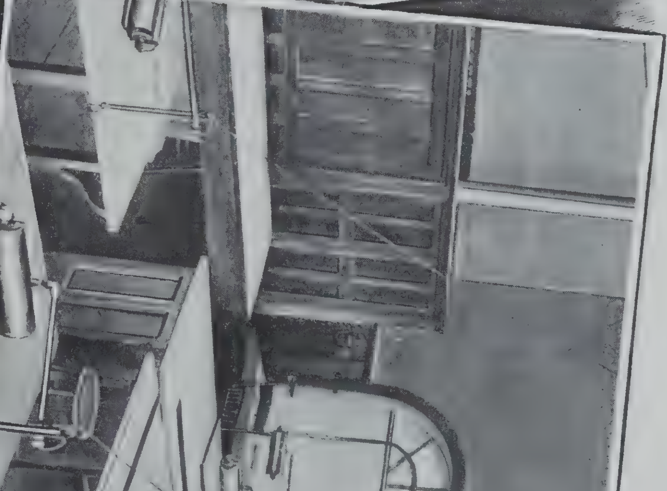


Fig. 4. Northeast corner of Drawing Room.
Fig. 6. Southeast corner of Drawing Room, showing Blueprint Department.

of a drawing on the table, and completely shade the eyes of the draftsman.

The southwest corner of the drawing room is shown in Fig. 5. Arranged along the wall under the windows is a series of lockers for the use of the employees, while to the left is ample provision for washing. At the extreme right is the reference table, provided for general reference purposes. It usually holds a supply of books, magazines, reference drawings, data sheets, etc. When this photograph was made it was being used to accommodate extra tracers.

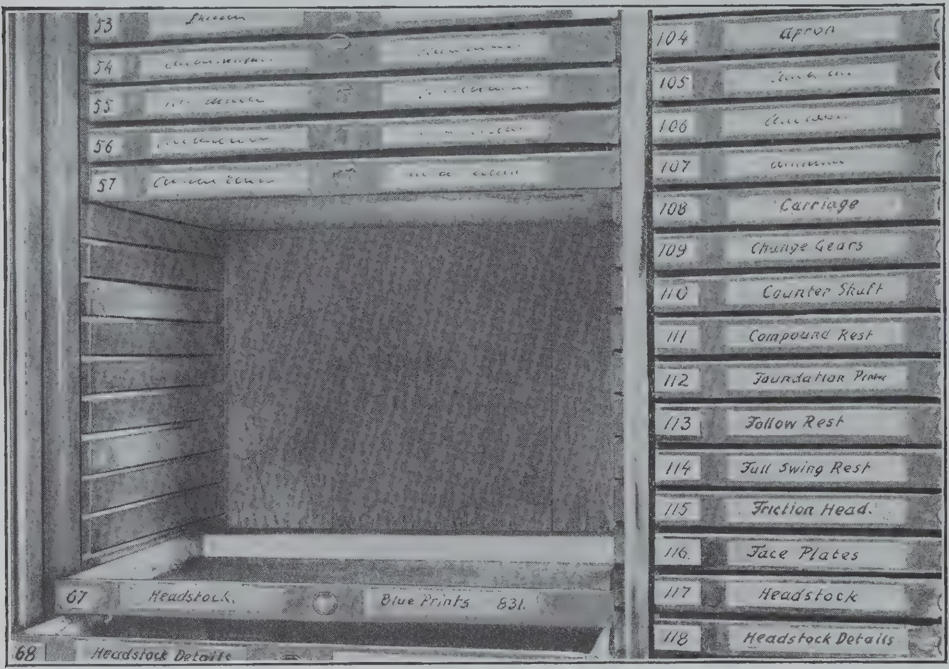


Fig. 7. Galvanized Iron Drawers of Print Filing Cabinet.

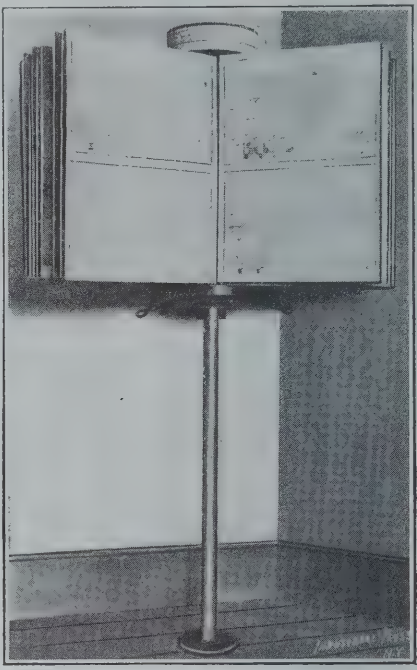


Fig. 8. Blueprint Reference Rack.

The blueprint department is located at the southeast corner, Fig. 6. In Fig. 2 is a larger view of the arrangement, which has several unique features. The blueprint frames are arranged on tracks under a plate glass roof, which allows printing in all conditions of weather when there is light enough for the purpose. The tracings and paper are held to the glass in the frame by atmospheric pressure by the use of a compressed air ejector to remove the air from between the glass and rubber blanket. This is a very convenient arrangement, and gives the most perfect prints from any kind of tracing, as the contact with the sensitive paper is bound to be absolute. One of the frames in Fig. 2 is shown in position for printing and the other for changing tracings. Shades are provided for cutting the strong light from the frame while changing the tracings. The frame carrying the rubber blanket, and to which is fastened the air hose, is hinged at the right of the glass frame and is fastened by buttons at the left. It requires but a few seconds after the blanket frame is closed for the air ejector to extract sufficient air from between the rubber and glass to allow reversing the frame. The shelves at each end of the plate-glass roof are used for small frames in cases where a single small print is required in a hurry, and for prints from negatives.

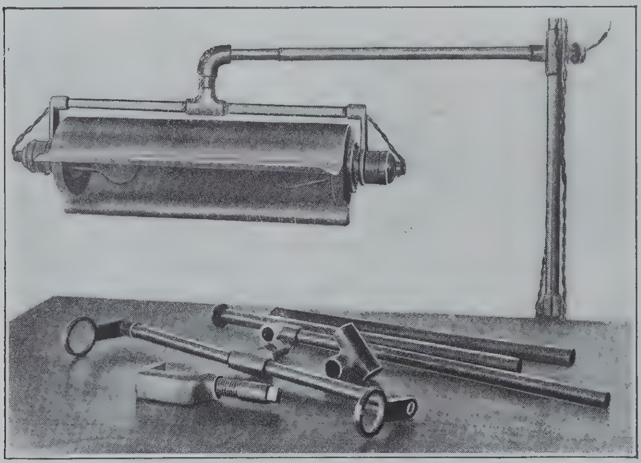


Fig. 9. Drawing Table Lamp.

The blueprint washer and dryer is located in the corner next to the printing frames, and is designed to take as little space as possible. An endless chain carries the prints to the ceiling and back again in the drying process. The floor of this printing department is raised about two feet above the drawing room floor on account of the height of the windows on this side of the room. This height, far from being the handicap we anticipated, has proved to be rather in the nature of an advantage, keeping this department within its own limits, although decidedly limited in space.

The large cabinet of drawers in the center of the illustration, Fig. 6, is used for filing large sheets of original drawings or lay-outs, each drawer being assigned to a single size of lathe or class of drawings, and is of sufficient size to take in a sheet the full size of the drawing without folding. The top of this cabinet is partially covered with plate glass, which forms a table to be used for cutting paper, etc. The front

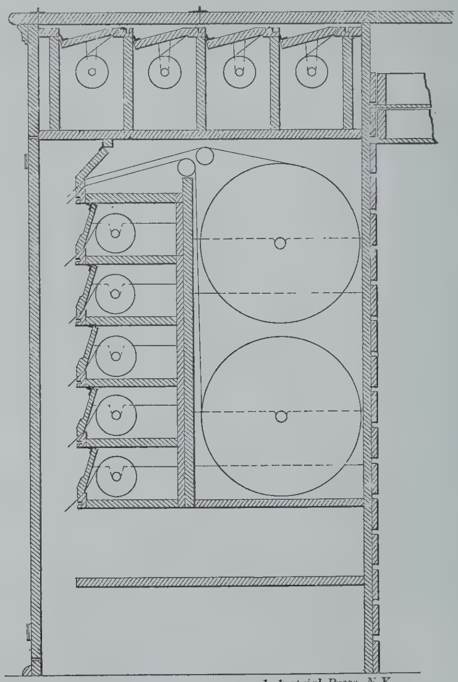


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Fig. 10. Sectional View of Cabinet for Storing Blueprint and Drawing Papers.

end of the cabinet is arranged in compartments for storage of rolls of blueprint and drawing papers, and a sectional view is shown in Fig. 10. The four compartments at the top, access to which is secured by raising a section of the top of the cabinet, is reserved for the print papers, four kinds of which are always on hand, and any amount of either can be drawn out without exposing the roll to the light. The compartments on the sides are used for tracing cloth and drawing papers, while the large central compartment is for detail paper and wrapping paper which we use largely for covers to protect the drawings sent into the shop. The cover of each of these compartments is held in place by spring hinges which hold it against a hardwood strip provided with a groove for guiding the knife in cutting the paper.

At the left of the view, Fig. 6, is a cabinet for the storage of extra small drawing boards. On the top of this cabinet is a shear for trimming prints and cutting paper into our standard sizes for use on the tables; also a letter press, used principally for the binding process through which all our data sheets are put. This cabinet has recently been replaced by a table similar in size and construction to the tables used by the draftsmen. Ventilation and cooling in summer is effected by several electric fans and also by a motor-driven exhaust fan mounted in the ceiling.

Visitors are cordially welcome at the Lodge & Shipley plant, and the writer will always be glad to show a Machinery reader through the company's drawing-room.

* * *

STEEL AND ITS TREATMENT.—2.

METHODS OF HEATING STEEL.

E. R. Markham.

As stated in a previous article, it is very necessary in order to get satisfactory results that steel be heated uniformly for hardening. In order to get uniform heats when hardening work in large quantities, various methods of heating are used, the method generally depending on the facilities furnished in the shop where the work is done. For instance, if in a shop ten thousand pieces of work are to be hardened, the equipment of the shop is oftener taken into consideration than the very best method of doing that particular piece if it entails an outlay of money to instal the better method. This way of doing is necessary, unless the amount of money saved by the addition of the extra equipment would pay for itself or produce an article enough better in quality to cover the expense incurred. For example, if a manufacturing concern had fifty thousand bicycle cones to harden, and their only method of heating them was an open fire, of the form of a blacksmith's forge, it would cost (estimated) 50 cents per hundred; provided the work was done by a man sufficiently experienced to get satisfactory results. The total cost for hardening the lot would be $250 for labor. Now if a lead-hardening furnace were used to heat the cones, the cost of hardening could be reduced to 10 cents per hundred or a total cost of $50 for labor, saving $200. And as a lead-hardening furnace large enough for any ordinary work can be purchased for $125, the cost of installing the furnace would be saved, with an additional saving of $75. The cost (50 cents per 100 cones) of heating in an open fire is simply an estimate and is given for the sake of illustration; while the amount of 10 cents per 100, given as cost of heating in the lead-hardening furnace is taken from a book of piecework prices paid for work when I was connected with a concern manufacturing bicycles; the men making very satisfactory wages at the rate mentioned.

Many pieces of work may be heated at one time in a large muffler furnace at a much less cost than if an ordinary open fire were used, and with much more satisfactory results. If the work is done in large quantities the price of the muffler furnace may be saved. This is to show the young hardener that the matter of equipment is generally looked at by the manufacturer from a commercial standpoint. If the manager, superintendent, or those having the purchasing of equipment in charge, can be convinced that a saving in cost of production, without a deterioration in quality of product, can be accomplished by the purchase of additional equipment, they are generally very willing to go to the necessary expense. And even if they feel they cannot purchase the equipment advocated, they look upon it as a very favorable sign when a young man is endeavoring to, in any manner, decrease the cost of production in the shop. And the manager, when he finds it necessary to put someone in a responsible position, will certainly favor the man who shows an untiring interest in the welfare of the concern employing him.

When large quantities of small pieces are to be heated for hardening and an ordinary forge is the only means obtainable, a number of pieces of gas pipe of suitable size and length may answer. One end should be closed by means of a cap screwed on, or a piece of steel or iron may be made to fit the hole in the pipe, and a piece ⅜ inch to ½ inch thick may be fastened in one end with screws or pins. The pieces to be hardened are then placed in the tubes, care being taken that no more pieces are put in at one time than can be heated uniformly. If a number of pieces of pipe are used at a time there will be a saving in cost.

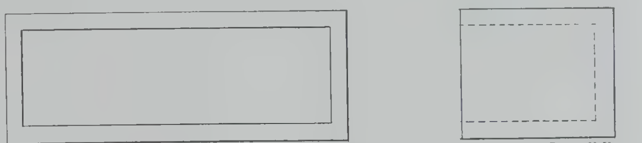
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Fig. 1.

It is possible to make an oven of the form shown in Fig. 1 for use in heating articles in the open fire. This may be placed on two pieces of brick or iron in such a manner that the fire may be under, on top, and at the back of it; the coals may also be piled up at the ends. The work which is supposed to be inside the oven and on the bottom heats very uniformly. When the work is first put in this receptacle it may be placed near one end, then as it heats it may be moved toward the center. In this way it does not heat too rapidly, neither do the cold pieces as they are placed in position at the ends chill the pieces in the center, which are red hot and are allowed to remain a few minutes in order to become heated uniformly throughout. A crucible of red-hot lead provides an excellent means of uniformly heating work in large quantities. A ladle, dish or crucible of lead may be heated in an ordinary forge and very satisfactory results obtained in heating the work. This, however, will necessarily be a slow method as compared with furnaces made specially for the purpose. But if obliged to heat the lead in this manner, bricks may be so arranged as to make a place for the crucible and allow the fire to be under it and around it, which furnishes a very uniform heat. It will be found necessary, however, to raise the crucible occasionally and poke the coals underneath it; the lead will also cool somewhat when fresh coal is placed on the fire. The very best results can always be obtained if steel is hardened at the refining heat, that is, the steel should be heated to that degree that when plunged in the bath and hardened the fracture (if the piece be broken) will show a very fine compact grain. Consequently it is necessary to keep the lead at the proper temperature, as nearly as possible, to produce the desired result. If it becomes too cool do not attempt to use it; wait until it is at the proper temperature. If it should get too hot do not continue using it, thinking it will soon cool off. Every piece heated when the lead is in this condition will not give the results it should. If the lead becomes too hot plunge a large bar of cold iron or scrap steel into it, allowing it to remain until it absorbs the extra heat and reduces the temperature of the lead to the proper degree. Then, and not till then, it is safe to go ahead with the work.

One reason why so many fail to get satisfactory results in the use of red-hot lead as a heating medium for hardening steel is because they use a quality of lead unfitted for the purpose. Steel, when in a red-hot condition, is very susceptible to impurities, and the ordinary grades of pig lead are apt to contain impurities very harmful to steel. For this reason scrap lead of an unknown quality should never be used; neither should any brand of pig lead containing sulphur be allowed to come in contact with red-hot steel. I always make it a point to use nothing but chemically pure lead in a crucible to be used for heating steel.

To prevent the surface of the lead from oxidizing from the action of the air upon it the top of the lead should be covered with charcoal, broken in pieces the size of a walnut. This also has a tendency to keep the surface from chilling as the charcoal catches fire and burns. The surface of the lead will oxidize somewhat, however, forming what is familiarly known as dross. This should be skimmed off occasionally or it will stick to the work in spite of all precautions taken to prevent it. As the surface of the lead is exposed to the air and is cooled somewhat by it, and as the tendency of the fire is to heat the lower part of the crucible hotter than the top, it is necessary to occasionally stir the lead in order to obtain uniform heats. This is especially true if long pieces projecting down into the lead are to be heated.

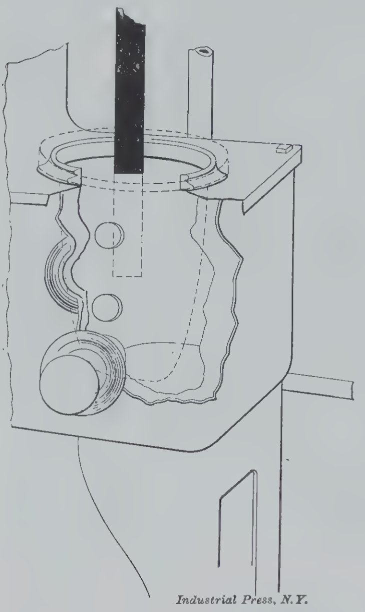
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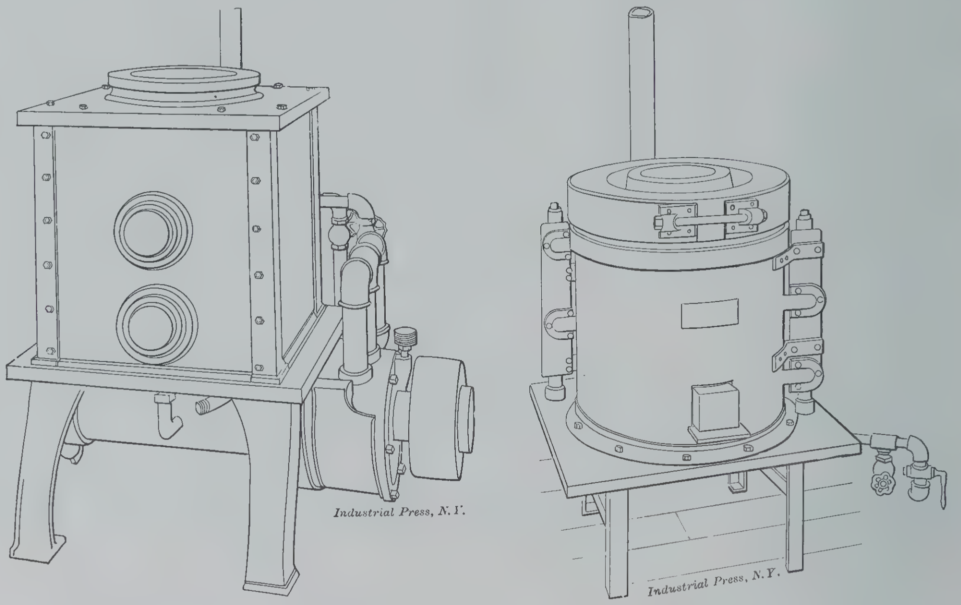
Fig. 2. Heating Steel in a Lead Bath.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Figs. 3 and 4. Types of Gas-heating Furnaces.

Many mechanics object to the use of red-hot lead for heating steel because the lead has a tendency to stick to the steel, which is especially the case in heating tool steel at a low heat. The higher the heat the less tendency the lead has to stick to the steel; but it is not advisable to overheat steel simply to prevent the lead from sticking, and for this reason many have abandoned its use rather than spoil the tools they wished to harden. But there are several dips that may be used which will effectually prevent lead sticking to steel when at the proper hardening heat. Some use a strong solution of salt and water, dissolving all the salt possible in a dish of water; others use a solution of cyanide of potassium and water, dissolving one pound of cyanide in one gallon of water. The cyanide should be crushed or pounded fine and dissolved in boiling water. Great care should always be exercised in the use of this chemical as it is very poisonous. If the solution is not strong enough a greater proportion of cyanide may be added. When using either of the above solutions the work should be dipped in them and allowed to dry before putting it in the lead. For any form of moisture is converted into steam when brought into contact with the red-hot lead, and this will cause the lead to sputter and fly, and wherever these particles strike they are very apt to burn, especially if they strike in the eye. A very good plan is to place the pieces of work, after dipping in the solution, on top of the furnace or on the bricks of the open fire mentioned, allowing them to remain there until dry, when they may be placed in the lead. If a number of pieces are placed in the lead at one time and an equal number approximately are dipped in the solution and put in position to dry, then the work may be done in rotation, that is, while the pieces in the lead are heating, those on the furnace will be drying. As soon as the pieces in the lead are sufficiently heated they are taken out, one at a time, with hook or tongs and plunged beneath the surface of the lead to insure even heating. Then the piece is removed and dipped in the hardening bath. While the pieces are heating it is advisable to turn them occasionally in the lead to insure uniform results.

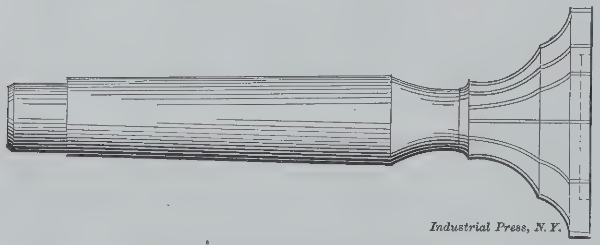
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Fig. 5.

A piece of steel heated in red-hot lead in such a manner that a portion of it was not submerged in the lead, as shown in Fig. 2, should be moved up and down in the lead a trifle to avoid what is known as a fire crack. That is, the steel below and at the surface of the lead would be subjected to an intense heat, while the steel above the surface would be at nearly its normal temperature; and as the effect of the heat is to expand the steel, the point where it ceased expanding would be at or about at the top of the lead, and if held stationary in the lead the effect on the steel is liable to be disastrous. To avoid any such result the piece should be raised and lowered somewhat in the lead, distributing the strain over a larger surface and thus doing away with the tendency to crack. If pieces of irregular contour, differing greatly in size at different portions as shown in Fig. 5, are to be heated in lead, it is advisable to heat them nearly to a red in an open fire or in some manner to avoid the unequal strain to which the piece would be subjected were it to be plunged when cold into red-hot lead. It would be impossible for the large and small portions to expand equally, and the consequence would be a crack or innumerable cracks; and, unless the operator were aware of the effects of violent, uneven heats on high carbon steels, these cracks would be laid to the bath, that is, he would think the steel cracked in the cooling bath, when in reality the cause was sudden expansion rather than contraction. If the fracture were examined the walls would be found black, whereas if a piece cracks from dipping in the bath the surfaces of the fracture will be bright. They may be stained by the contents of the bath coming in contact with them, but they will not be black.

When articles having fine teeth such as rotary files, cherries, small reamers, milling machine cutters, etc., are to be heated in lead, a paste may be made that will prevent the lead sticking between the teeth, even when the dips mentioned fail to give good results. The kinds and proportions of the ingredients are given in the following table which is taken from the report of the Chief of Ordnance of the U. S. War Department:

Pulverized charred leather............	1	pound
Fine family flour......................	1½	pound
Fine table salt........................	2	pounds

The charcoal made from the charred leather should be crushed until fine enough to pass through the meshes of a No. 45 sieve.

The ingredients are thoroughly mixed in a dry state, and water is added slowly to prevent lumps until the paste has the consistency of ordinary varnish. The paste is applied with a brush. The articles are placed where they will become thoroughly dry; yet they must not dry fast enough to cause the paste to crack, neither must the pieces be put in the lead until thoroughly dry or the steam generated will cause the lead to fly, as before explained.

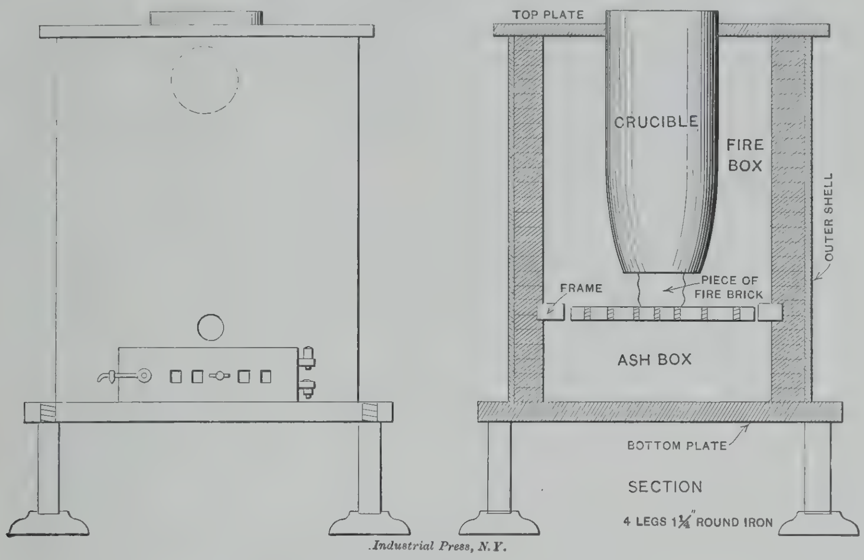

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Fig. 6. Heating Furnace for use with Hard Coal.

If large pieces of steel or tools of irregular contour are to be heated in lead and it is not possible to heat nearly to a red in another fire with a slower heat, the article may be immersed in the lead and withdrawn, then immersed again, leaving it a trifle longer than the first time. This operation is to be repeated until the steel has absorbed enough heat to preclude the liability of cracking. Then it may be left until it is heated uniformly throughout to the desired heat.

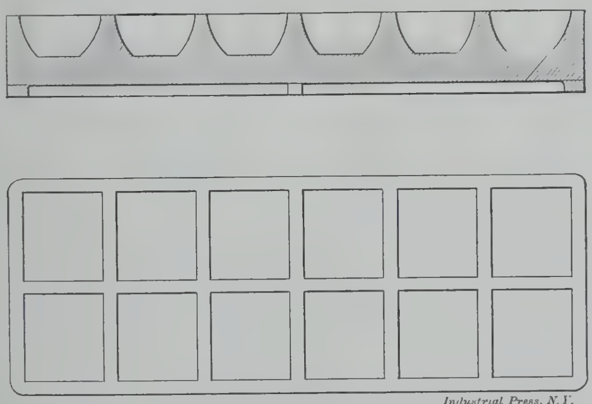

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Fig. 7. Mold for Lead when Poured from Crucible.

The question may be asked, If pieces of the shapes mentioned can be better heated in a slow fire until nearly to a red, why not heat to a red and do away with the lead crucible entirely? The object in finishing the heat in the lead is that once the lead is brought to the proper temperature any number of pieces may be heated uniformly, provided proper attention is given the lead. According to my experience, red-hot lead provides an excellent means of heating small tools or parts of machines, etc., when the work is hardened in large quantities and when the cost of labor is a factor to be considered. For this method to be a success when considered from a commercial standpoint, it is necessary to provide some means whereby the lead may be kept at a uniform temperature throughout the entire working day, or, at any rate, such portion of it as needed for the necessary amount of work. If a furnace burning illuminating gas can be procured it will be found one of the most satisfactory and most economical methods of heating where the price of illuminating gas is not too high. Very satisfactory forms of gas-burning furnaces are shown in Figs. 3 and 4. If not situated where illuminating gas can be procured at reasonable rates, and it is not considered advisable to instal the necessary apparatus for heating by gasoline or oil, a furnace may be made to burn hard coal, coke or charcoal. While it is not generally considered possible to maintain as even a heat as with gas, yet by exercising reasonable care very uniform results may be obtained.

Fig. 6 shows a sectional view of a furnace intended for burning hard coal. The outer shell may be made of cast iron, although it is often possible to find at a junk dealer's an old boiler which can be bought for a "song." A piece the proper length may be cut from this that answers admirably for the outer shell. A round grate and the necessary frame to support it may be procured from a stove dealer. A grate of the form used in the ordinary cylinder parlor stove answers every purpose. The frame should be attached to the shell or blocked up sufficiently high from the plate which supports the outer shell to allow the grate to be turned in dumping the contents of the furnace. It is necessary to cut an opening in the front of the shell at the bottom, which should be covered with a door containing a sliding damper. This door is necessary in order to remove the ashes. The inside, from the frame to the top of the shell, should be bricked with circular fire brick, or, if possible, with a stove lining of the proper size. Over the top must be placed a plate having a hole in the center one-half inch larger than the size of the top of the crucible to be used. A smoke pipe must also be provided, to carry off the smoke and gas from the fire. This can be connected with the shell at the top on the back side of the furnace, and should also be connected with a chimney and provided with a damper for use in regulating the draft. The plate covering the top of the furnace may be cast in two pieces, having more than half the hole in the part that goes at the back. The smaller or front half may be moved forward, thus affording an opening to feed the coal to the fire. The object in having more than one-half the hole in the back part of cover is to prevent the crucible from tipping over when the front plate is moved if there were not sufficient coal in the fire to support it. It is also necessary to rest the crucible on a piece of fire brick as shown in Fig. 6. If a black lead crucible is used to hold the lead, much better service can be obtained if the crucible is annealed before using. In order to do this the crucible should be placed in some fire where it can be heated all over to a red heat. It should then be removed and placed where no current of air can strike it and allowed to remain until cold. It will then last much longer than if used without annealing.

It is necessary to remove the lead from a black lead crucible before it cools and solidifies, or the crucible will crack when heated again. When doing this it is dipped out with a ladle until the crucible is nearly empty, when it may be removed with tongs and the balance of lead emptied out. As it is necessary to put the lead in the crucible in small quantities when heating, it is advisable to have a mold made, of the form shown in Fig. 7, to turn the lead into when removing from the crucible. This mold resembles a muffin pan, and the compartments serve to cast the lead in pieces of the proper size to put in the crucible when reheating.

If the above instructions are carefully followed excellent results will follow the use of this method of heating; but if scrap lead or pig lead of an inferior quality is used then trouble will surely result. My advice would be: Rather than to attempt doing things by halves, do not attempt the use of red-hot lead for heating tool steel.

* * *

A foreign writer, Aug. F. Weiner, states that the addition of a small quantity of ferro-vanadium has the property of raising the tensile strength of mild steel by from 50 to 66 per cent.—*Sparks from the Anvil.*

EARLY MACHINE SHOPS AND MECHANICS.

HISTORICAL NOTES ON THE DEVELOPMENT OF THE MACHINE SHOP DURING THE EARLY PART OF THE NINETEENTH CENTURY.

The last century was remarkable for being a distinctly mechanical era. At its beginning the machine shop scarcely existed except in the most primitive form, and machinery of any but the crudest types was practically unknown. The clock and the watch of that time undoubtedly represented the highest development of any mechanism built for specific purposes. Agriculture and other industries were being pursued in almost the same manner as at the beginning of history. Transportation on land was effected by rude carts or wagons drawn by animals and on water by vessels propelled by sails or oars. The steam engine was just beginning to be recognized as a prime mover, but was generally unknown.

At the end of the nineteenth century, how are the conditions changed? The implements and machines for agriculture alone are almost unnumbered. The farmer sows the seed, reaps the harvest and threshes it by machinery. The steamship, locomotive and trolley car have come to be necessities for transportation. The steam engine is the prime mover of thousands of mills and factories and does the work of myriads of horses and millions of men. In every industry that then existed nearly every feature has been changed and many new industries have sprung into existence as a result of general mechanical development.

The building of machinery requires machine tools and the machine shop. The construction of the first steam engines, when the machine shop was in its infancy, were undertakings attended by almost unsurmountable difficulties. The machine shop became a necessity and has so developed that it is now an important factor in every industry and directly or indirectly influences every trade and profession.

In 1800 the pole lathe was the principal machine tool in use, although there were a very few lathes in existence having a rotating spindle driven by a band from a flywheel turned by a foot treadle, and some other minor improvements. The pole lathe was about the simplest imaginable affair to be dignified by the name of machine, being little more than the primitive lathe of the ancient Egyptians. It consisted of a wooden frame set on legs and carrying a pair of poppets which held the dead centers on which the work revolved. The work was alternately rotated forward and backward by a cord wound around the work and fastened at one end to a pole or lath (from whence the name lathe) secured overhead. The lower end of the cord was usually made into a loop through which the operator thrust his foot to exert the motive power. A foot treadle was sometimes employed instead of the loop, the end of the cord being secured to one end. The disadvantage of having the work turn first forward and then backward led to the employment of means for making the rotation continuous. The first steps in this direction appear to have been by winding the cord around the work so that the work would be turned forward on the down stroke of the treadle, and when the pressure was removed so that the pole or lathe returned to its original position, the motion of the piece being turned would continue in the same direction on account of the peculiar arrangement of the cord. This scheme, however, never became popular as a large portion of the power exerted was lost in friction of the cord. With such a tool the turning of a piece of metal with any degree of accuracy was extremely difficult, since the operator was obliged to stand on one foot and manipulate his tool against the surface of work alternately turning in opposite directions.

The first rotating spindles for lathes were made from square iron turned for the front bearing and threaded on the end for the chuck. The thread for the chuck was sometimes made internal but the usual practice was to make it external, as now holds. The tail bearing of the spindle was formed by a pointed setscrew held in the back poppet head and engaged in the end of the spindle. The spindle thus turned in a box at the front and on a pivot at the back end. This arrangement had two advantages: It afforded a simple means for taking the thrust and also taking up the end play, and reduced the frictional resistance below that which would have resulted with the shaft running in two boxes. When the latter construction was finally adopted to obtain greater stability, the back bearing was kept as small as possible to make the shaft run easily. The influence of this practice is seen in most modern engine lathes to-day when the reason for it no longer exists.

The shears of the old time lathes as well as all other parts except the spindle and centers were made of wood. The head poppet being made in two parts framed into the bed, it was almost impossible to keep the spindle in alignment with the tail center. To obviate this trouble J. J. Holtzpffal, England, made a headstock in 1794 of cast brass having its base and the front and rear bearings one integral part. This was found to be such an improvement that headstocks were subsequently made of cast iron by him. The patterns were made so that the sections of the castings were generally of uniform thickness, as is the present practice, instead of following the square shapes of the wooden parts made by the carpenter.

The most important improvement, however, ever made in the lathe and which is a distinguishing feature of every modern machine tool except the drill press, was the invention of the slide rest by Henry Maudslay in 1794. Maudslay was at this time a workman in the shop of Joseph Bramah, generally known as the inventor of the hydraulic press. This invention replaced the cutting tool held in the uncertain grasp of the workman's hand by a tool held in a hand of iron and it furnished the means of guiding the cutting point in mathematically straight lines. The slide rest made accuracy possible and enabled the production of perfect cylinders in the lathe and later the production of accurate plane surfaces in the planing machine. The slide rest at first was generally opposed and ridiculed by the workmen who nicknamed it "Maudslay's go-cart," but it was not many years before it became commonly used, as was its manifest destiny. While the invention of the slide rest was undoubtedly original with Maudslay, it appears to have been anticipated by many years in France, having been illustrated in the French Encyclopedie published in 1772. The latter device differed materially from the invention of Maudslay and as it had apparently never been developed beyond an experimental stage, or if so, had been allowed to go out of use, it is to Maudslay that we should give the credit for undoubtedly the greatest improvement ever made in machine tools.

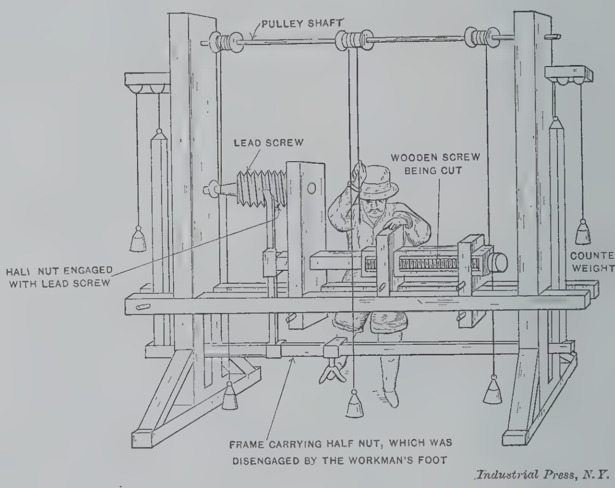
PULLEY SHAFT
LEAD SCREW
WOODEN SCREW BEING CUT
HALF NUT ENGAGED WITH LEAD SCREW
COUNTER-WEIGHT
FRAME CARRYING HALF NUT, WHICH WAS DISENGAGED BY THE WORKMAN'S FOOT
Industrial Press, N.Y.

Fig. 1. Jacques Berson's Wood Screw-cutting Lathe, 1569.*

The wood-working machinery erected in Portsmouth dockyard in 1807 under the direction of Maudslay, marked an important step in labor-saving machinery and had an important effect on the future design of metal-working tools. The machines were designed by Brunel and Bentham principally for the production of tackle blocks and when completed enabled 10 men to do the work of 110 men and in a far superior manner. These machines are said to have effected a saving to the English Government of about $120,000 annually. The making of tackle blocks was an important part of the equipment of a man-of-war, as a 74-gun ship had 1,400 blocks of various sizes.

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* The illustrations accompanying this article are taken from "Turning and Mechanical Manipulation," by Charles Holtzpffal, published in 1843.

It is thus apparent that at the beginning of the nineteenth century the lathe, while yet a very crude affair, was with Maudslay's invention of the slide rest, the progenitor of the wonderful machine tools which are produced from, and in turn make possible, the modern machine shop.

The importance of the screw as a machine element and as applied to studs and bolts for fastening machine parts together, was early recognized, but no means had ever been devised for securing ease of production and uniformity of product until the invention of the screw-cutting lathe. To whom this honor is due does not appear to be exactly clear. The first mention of a lathe arranged for screw cutting is that of Jacques Berson, a Frenchman who had a primitive rig arranged for cutting spirals in wood and which was subsequently arranged to cut threads in metals. A cut of this device is to be found in some old books which give a dim idea of its operation although it is hard to understand how such a crude tool could have been operative. In 1648 engravings were published in Rome of two curious machines, called by courtesy lathes, for the production of plane, spherical and hyperbolic mirrors. The cutting tool in these machines was held in a sort of carriage mechanically controlled so that if need be the same machines could have been adapted to the cutting of helices although there is no evidence that this was ever done. Another lathe referred to by historians is that of Joseph Moxon, about 1680, for the production of "swash" work, which was then very popular. It is said that Moxon made these lathes for sale and that they were much sought after, as they were well made and generally excellent tools. Again, there is no evidence to show that they were specially adapted to the production of screws, although the tool was mechanically controlled and could have been arranged to secure the result with little more complication. A machine appears to have been used by the early watchmakers for the production of screws, working on substantially the same principle as the screw-cutting lathe, although it was adapted for the production of only one lead. The face plate on the spindle (it being a rotative spindle), was a gear and meshed in another gear mounted on a screw running parallel with the shears, as in the modern tool. The carriage was furnished with a nut engaging with the screw, so that the production of screws of various diameters but of uniform lead was possible.

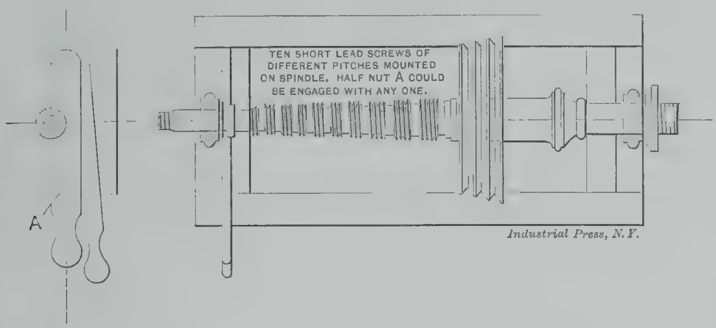

TEN SHORT LEAD SCREWS OF DIFFERENT PITCHES MOUNTED ON SPINDLE. HALF NUT A COULD BE ENGAGED WITH ANY ONE.
A
Industrial Press, N.Y.

Fig. 2. Early French Mandrel with Ten Leads of Thread for Thread Cutting.

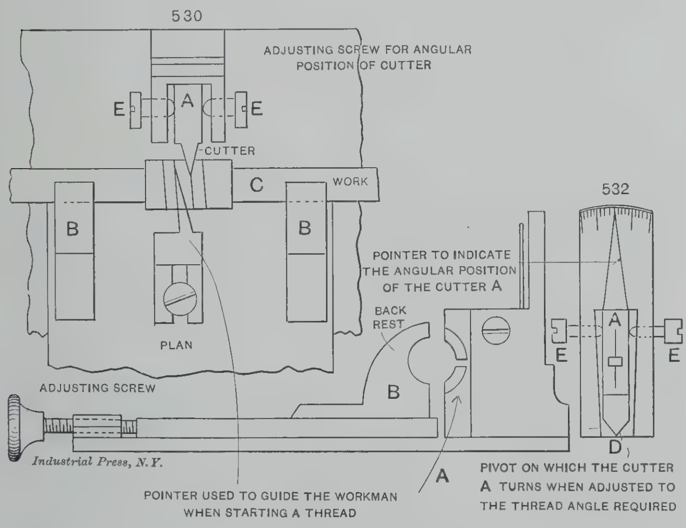

530
ADJUSTING SCREW FOR ANGULAR POSITION OF CUTTER
E
A
E
CUTTER
C
WORK
B
B
PLAN
532
POINTER TO INDICATE THE ANGULAR POSITION OF THE CUTTER A
BACK REST
A
E
E
B
ADJUSTING SCREW
D
Industrial Press, N.Y.
A
POINTER USED TO GUIDE THE WORKMAN WHEN STARTING A THREAD
PIVOT ON WHICH THE CUTTER A TURNS WHEN ADJUSTED TO THE THREAD ANGLE REQUIRED

Fig. 3. Allen's Device for Originating Screw Threads for Astronomical Work.

Another method which appears to have been extensively used, was that of having a thread cut on the spindle which was arranged to slide longitudinally in its bearings. The work was held in a chuck and the tool remained stationary, as in Healey's lathes of 1804. A nut being engaged with the screw on the spindle, the same lead was generated on the piece held in the chuck. One elaborate machine is illustrated in Holtzpffal's "Turning and Mechanical Manipulation," in which the idea was carried out so that ten different leads could be cut in this manner, ten screws being cut on the spindle along a portion of its length and ten half-nuts with supporting keys any one of which could be engaged as desired. It is probable, however, that this machine was built after 1800.

The various means adopted by the old-time mechanics for the production of original screws, are very interesting but can be only briefly touched on here. One was to wrap a strip of paper around the blank cylinder of metal or wood as the case might be, so that its edge would form a helix of the desired pitch. This edge gave the workman his guide for the cutting tool when the piece was mounted in the lathe. Imagine cutting threads in such a manner!

It is recorded that Anthony Robinson at the Soho works of Boulton & Watt made in 1783 an original screw seven feet, six inches long and six inches diameter with a triple square thread, pitch not given. The thread was laid out by wrapping a sheet of paper around the blank so that the edges when trimmed just met. The paper was then removed and the threads laid out as lines running across the paper at the proper angle, Robinson evidently understanding that a screw is the same as a right triangle wrapped around a cylinder so that the hypothenuse is the helix, the base the circumference and the altitude the pitch.

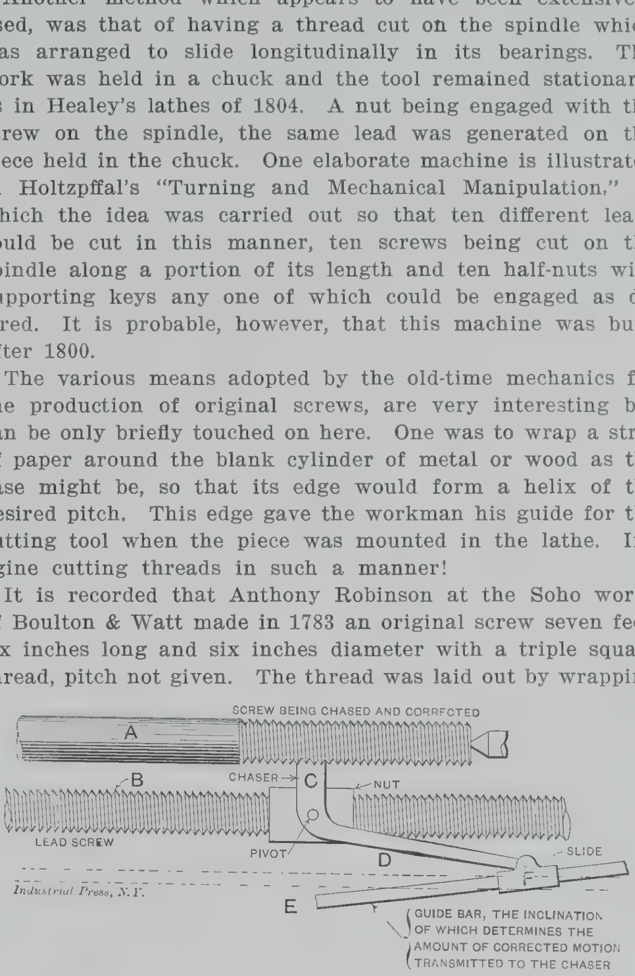
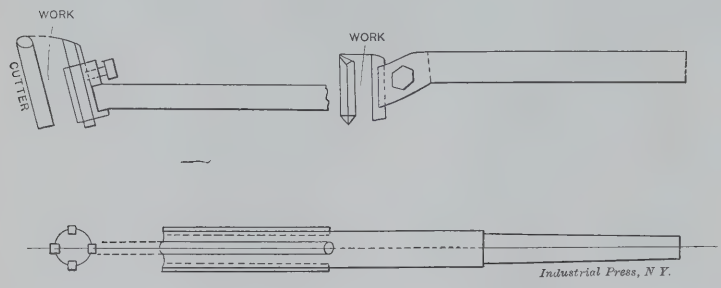

SCREW BEING CHASED AND CORRECTED
A
B
CHASER
C
NUT
LEAD SCREW
PIVOT
D
SLIDE
Industrial Press, N.Y.
E
GUIDE BAR, THE INCLINATION OF WHICH DETERMINES THE AMOUNT OF CORRECTED MOTION TRANSMITTED TO THE CHASER

Fig. 4. Maudslay's Thread Correcting Device.

After the lines were laid out and inked, the paper was replaced on the blank and the lines pricked through the paper into the metal underneath. The paper was then again removed and one thread, shallowly chipped and filed out. The partly formed screw was then stood on end, being thrust through a shallow square cast iron box. The hole in this box around the cylinder being luted with clay, it was filled with melted lead, and when the lead cooled, the cast iron box formed a rude nut on the unfinished screw. A cutting tool was rigged on the face of the box with proper adjusting devices so that it could be fed into the cylinder and then the box having levers attached was handed around by the lusty workmen. In this manner the other grooves were cut of the same pitch as the first and the first finished to the desired depth. The recital of these operations gives some idea of the tremendous difficulties encountered in machine construction at the beginning of the century.

The problem of accurate screw cutting was one that peculiarly appealed to Maudslay, as he had a keen appreciation of the desirability of such a condition and of the immense advantages to be secured by its solution. Some of Maudslay's efforts in the line of accurate screw cutting after becoming the proprietor of a shop would not be half bad now if the records can be believed. He is said to have made a screw for astronomical work 60 inches long, 50 threads per inch, on which was screwed a nut 12 inches long, so that 600 threads were engaged at the same time. The old timers evidently had a keen appreciation of the law of averages, as is shown by the use of the long nut. The importance of standard planes and surface plates was appreciated by Maudslay, who supplied them in numbers in his shop and required all plane surfaces of importance to be perfected by their use. He also believed in exact measurements and had a bench micrometer called the "Lord Chancellor," as it was the court of last resort in the matter of measurement and by it the system of gages used was derived. The invention of the micrometer did not originate with Maudslay, but is claimed for William Gascoigne in 1648.



Industrial Press, N Y.

Figs. 5 and 6. Inserted Cutter Lathe Tools used in Portsmouth, England, about 1830; and Inserted Cutter Reamer of about the same date.

Maudslay's work in the production of accurate screw threads seems to have been principally along the lines of generating a thread by a tool set at the required angle for the thread and after getting one perfect helix, to reproduce it by the combined angular position of the cutting tool, together with a guide finger working in the helix already cut. He evidently considered that a mechanically operated carriage introduced an element of uncertainty which was fatal in the days of slender and inaccurate construction.

One thing is certain that although Richard Roberts brought out an improved screw cutting lathe in 1816, the art of cutting threads by a mechanically controlled carriage did not for many years become general. There are old mechanics living to-day who remember well the trials and struggles of their apprentice days when learning to use the chaser for cutting a thread. The tyro was very likely to produce a thread irregular in travel, having a wavy appearance and aptly characterized as "drunken."

The work of Maudslay in the production of accurate screw threads was followed by that of Clement and Whitworth in England and Sellers in the United States, to the latter two of whom we are indebted for the modern system of interchangeable screw threads in England and the United States.

Joseph Clement of Manchester was the first to make taps having their thread numbers in proportion to the tap diameters. He was also the originator of the form of tap having the shank smaller than the hole tapped, so that the tap could be passed through without backing out. Clement's taps were fluted by a revolving cutter similar to the method now followed. This was in 1828, but the use of the milling cutter or circular file as it was then known seems to have been known many years previously. There are records showing that the milling machine was used in this country in 1818 at Middleton, Conn., and mention is made of the use of toothed cutters in 1664 by a Dr. Hooke, for cutting gear wheels. It is also recorded by Chas. Holtzapffel that inserted cutter thread and turning tools for the lathe were in use as early as 1830. The cuts given show that they were very similar to those now used.

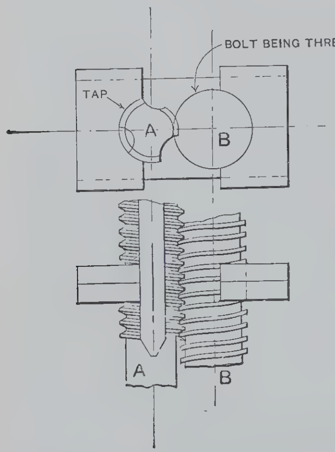


Fig. 7. Early Method of Cutting Left-hand Screws with a Right-hand Tap.

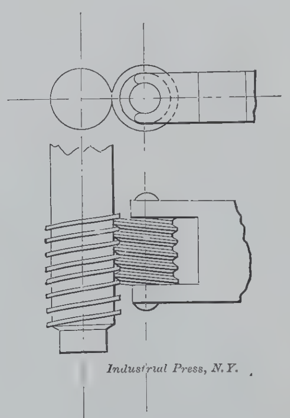

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Fig. 9. Showing that Thread Rolling is not a Recent Invention

In the construction of the first lathes having beds of metal, great difficulties were met in getting the beds straight and accurate as the planing machine was practically unknown. To get a form that would require a minimum of fitting, the beds appear to have been at first made in triangular section. All fitting and accurate work was thus confined to one angle which also had the effect of holding the slide rest in position both vertically and laterally.

The invention of the metal working planer is variously ascribed to Roberts of Manchester, Fox of Derby, Matthew Murray of Leeds, Spring of Aberdeen, Clement and Rennie of London, who all appeared to have had some sort of planing machines at work from 1814 to 1820. Whether Murray's claim to the invention of the iron planer is valid or not, it is certain that he was a mechanic of no mean order as he designed and built a commercially successful locomotive in 1812 for the Middleton Colliery Tramway, Leeds, which ran for nearly fifty years before being relegated to the scrap heap. This locomotive burned coal.

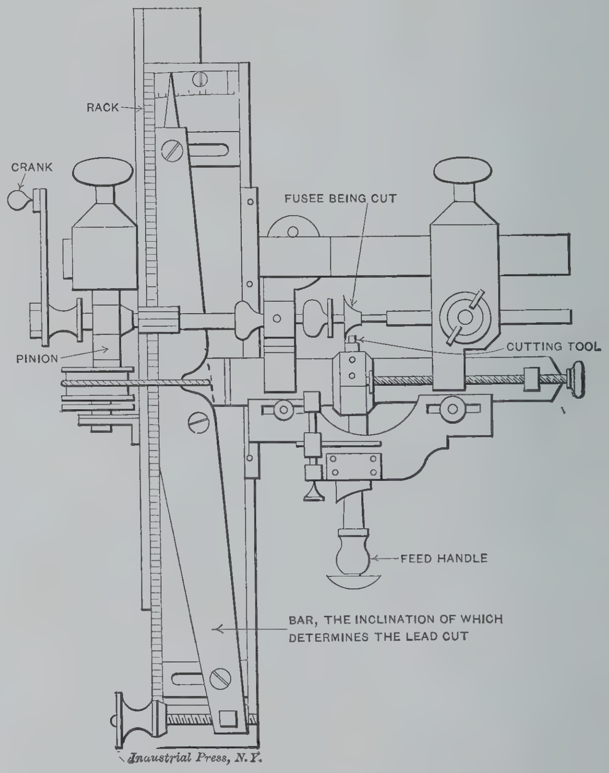

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Fig. 10. Le Lievre's Device for Cutting Fusee Threads.*

Joseph Bramah patented a planer in 1802 with a revolving cutter, but it was primarily designed for wood and appears to have been used for this purpose. There are records showing that Nicholas Torq, a French clockmaker, used a metal planer in 1751 for *boring* pump cylinders, apparently being under the impression that they could be made more accurate in this manner than by a revolving cutter. It is to Clement, however, that the honor of bringing out the first iron planer on the same lines as the tool is now built, evidently belongs. He had a machine in operation for planing the triangular bars for lathes in 1820 and built a more elaborate one of which a description was published in 1825. The cutting tool was stationary relative to the work and was held in a slide rest which was fed across the table. The tool cut on both strokes. The table or platen was mounted on rollers. The planer would take six feet square through the uprights. For ten years it is said to have been the only tool of the kind in existence. For much of the time it was kept in operation night and day on piece work. The charge for its services was over $4 per square foot of area planed, but at these enormous prices the machine was able to earn only (!) $100 per day, showing an area planed of about 25 square feet. The authority for this remarkable statement is "Industrial Biography," by Samuel Smiles, but we are inclined to question the accuracy of the price received for planing. As it was possible to have surfaces chipped and filed true for $1.50 per square foot at about the same time, it is not probable that Clement could charge three times as much for the same work done on the planer.

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* A device for cutting screws working on the same principle has recently been patented.

It is also stated that Clement used planer centers on these machines so that he was able to produce both flat and cylindrical work on the machine. Joseph Whitworth radically improved the planer by the application of the screw drive in 1839 and again Sellers of Philadelphia further improved it.

James Nasmyth, a pupil of Maudslay's, was an improver of machine tools and an inventor of a number. He is credited with the invention or adaptation of the slotter for metal work in 1836, the first machine being a modification of a machine for mortising holes in wood, designed by Maudslay. The invention of the flexible shaft for drilling in 1829, the keyseater in 1836, the crank driven shaper in the same year, the reversing or tumbler gear for changing the feed direction in lathes in 1837, the self-adjusting or spherical bearing for shafts in 1838, a tapping square for holding taps square with the work in 1840 and an end mill for keyseating shafts in 1847 are credited to him. In 1848 he made a punch for punching boiler plates having a skewed face to give a shearing cut. His invention of the steam hammer in 1839 was an important advance in the art of blacksmithing and made a radical change in forging operations, making work possible that had never before been attempted. The increase in the size of forgings and other changes in machine construction materially affected machine tools and led to radical changes in design. So decided were these changes that the machine tools made by John G. Bodmer in the few years from 1839 to 1841 contained almost every improvement of importance now found in modern tools.

It is thus apparent that the early development of machine tools took place in England, the English mechanics having anticipated practically every form of machine tool and method of working metals. The changes that have since taken place have been with few exceptions more in methods and minor changes than in radical ideas.

Early Machine Shops in the United States.

The early history of the machine shop in the United States is very uncertain, undoubtedly because the industry had never become of marked importance until well along during the past century. The first mention of a machine shop in what is now part of the United States that the writer has found is that of the Saugus Iron Works, Lynn, Mass., which were established in 1642, in which year they made the first iron casting poured in America, being an iron kettle which is yet preserved. The Saugus Works included a machine shop in which the first hand fire engine built in America was constructed for the city of Boston in 1654. The castings for this and other machines were made from bog iron ore and were made directly from the metal flowing from the blast furnace, the cupola for remelting the iron not being developed until 1790.

A machine shop was erected in the last years of the eighteenth century near Belleville, N. J., in conjunction with the Hornblower pumping engine imported from England for draining the copper mine at that place. Whether the machine shop was primarily intended to keep the engine in running order is not stated, but it apparently did outside work as we are informed that a pumping engine was built here for the city of Philadelphia in 1800. The engine when completed occupied the present site of the City Hall at the junction of Broad and Markets Sts. The steam cylinder was 38½ inches in diameter by 72 inches long, and its construction was a most difficult job with the crude and inefficient tools then in use. The boring of the cylinder took from the 9th of April, 1800, to about the middle of the following August, two men being in constant attendance night and day. This seems an incredible statement, but it is apparently sustained by the records at hand. It is highly probable that the cylinder casting, like most of the cast iron of that period, was extremely hard and very untrue, so that with the scraping cuts possible with the boring appliances used the amount of metal to be removed consumed an astonishingly long time.

In early engine construction as in other machines, as little machine work was incorporated as possible. Plane surfaces were tabooed in most shops, as they had to be surfaced by the chisel and file. The valve seat was the most important plane surface considered strictly necessary. The same general condition held in regard to bored holes. Such was the difficulty in boring true holes that on some of the early engines built, the cylinder was the only piece bored. The crank was cast with octagonal holes for the shaft and crank pin and was fitted to the shaft by thin wedges driven in so as to bring it approximately square with the shaft. The spaces unfilled with the wedges were filled with a cement made from iron borings and sal-ammoniac. The crank pin was fitted in the crank eye in the same manner. To make the throw correct for the stroke of the cylinder, it was often necessary to have the center of the working surface of the pin eccentric with the portion fitted in the crank.

The connecting rod was forged to shape and the holes for the strap bolts drifted out by the blacksmith as were the holes for the adjusting keys. The file was used for finishing.

A machine shop was started in 1801 by Robert McQueen on Duane St., New York. He was probably the first to make a specialty of building steam engines in the United States. After the success of the Clermont in 1807, Fulton established a shop in what is now Jersey City, where he built the Car of Neptune and finished steam engines, the iron castings being machined in New York by McQueen and Youle and the brass castings by James P. Allaire. What was subsequently the Allaire Works was started by Allaire in 1816. They became famous as builders of marine engines and other machinery. This firm had what is thought to be the first planer in America, built for fluting rolls and was in use in 1828. Such a then important business as the Port Richmond Iron Works, Philadelphia, Pa., had no iron planer until 1838. One of the first industries in the United States that stimulated the use and development of machine tools was the manufacture of cannon at the Fort Pitt Works, Pittsburg, Pa., which were established in 1814. A boring mill was erected at this date and cannon were bored and finished, the motive power being furnished by horses. At these works the famous Rodman cannon were subsequently made.

One of the early machine shops which had an important place in the early part of the century as machine tool builders was Silver & Gay, North Chelmsford, Mass., established in 1832. They built their first planer in 1836, having a capacity of 3½ feet square and driven by a chain. This is thought by some to have been the first planer built in America, but was not the first one in use, as shown in a previous paragraph. This planer had one V-way and one flat way set on directly on a granite bed. The table was driven by a heavy flat chain very similar to modern sprocket chains. This remarkable tool was still running in 1896. In this shop was built a 16-foot boring mill about 1840, having three heads, all of which had power feed. The center head was arranged to act as a slotter for keyseating the hubs of pulleys after they had been turned and bored. This firm built lathes, for their own use at least, having the usual chain feed mechanism commonly in vogue at that time for moving the carriage, but in addition some of them had power cross feed, one referred to in MACHINERY, February, 1896, being an example, and this was thought to have been built shortly after the firm started in business. This lathe was of about 48-inch swing and had a granite bed on which were mounted the cast iron shears. The tailstock had a set-over made on about the same plan as holds in modern engine lathes for turning tapers. Drill presses with power feed for both table and spindle, well adapted for heavy work, were built and sold by them between 1840 and 1850. They were pioneers in the building and development of the milling machine, having made them for sale as early as 1841. Frederick W. Howe afterward actively identified with the milling machine and turret lathe, learned his trade with this firm, finishing it about 1854. A spur gear cutter was built and sold to the Stark Mills by this firm in 1839 and one which was kept in their own shops in 1841. The work arbor of this machine was vertical, the index wheel being mounted below the upper part of the frame. The cutter spindle was on a horizontal axis, but was capable of being swung around sideways for gashing wormwheels and backward for bevel gears. Whether it was successfully used for cutting bevel gears is not positively known. The planing of bevel gears was taken up and a machine built for the purpose in the early fifties. The frame was made of wood with the working parts of iron and steel. The cutting tool was guided by a former and swiveled so as to cut both ways. In this machine the former was set so that the motion derived from its contour was reduced at the tool point, thereby reducing instead of multiplying any inaccuracy and also tending to make the former, which was of wood, last longer. For this machine the Silver & Gay Co. were awarded a gold medal in 1857 at the Middlesex Mechanics' Association.

* * *

HOLLOW FORGINGS.*

HOW NEW METHODS HAVE IMPROVED HEAVY FORGINGS

There are two ways of making a forging hollow. The ordinary way of getting rid of the center of a forging is simply to bore it out. After boring it is tempered, and thus the strength is restored which was taken away with the material that was in the center.

Another way of getting rid of the center of large forgings is to forge them hollow. A person who has not considered the subject carefully would naturally think that the first thing to do in making a hollow forging would be to cast a hollow ingot. There are various defects which occur in ingots, however, the most serious of which are "segregation" and "piping," and it is in the center and upper portions that those defects occur. If an ingot were to be cast hollow a solid core of fire brick or similar material would replace the center metal, and instead of one on the outside, there would be two cooling surfaces, one on the outside and one around the core, and the position of last cooling would be transferred to an annular ring midway between those surfaces where the "piping" and "segregation" would collect. This would not be satisfactory because the metal there, is what must be depended upon for the strength of the hollow forging. It is necessary, therefore, to collect the "piping" and "segregation" in the center and at the top, where metal has been added to the original ingot for the purpose. Then, having cut off the top and bored out the center, the "piping" and "segregation" are entirely eliminated, and what is left is as sound and homogeneous a piece of steel as can be obtained.

After the hole has been bored in the ingot, the next process is to reheat it, and, as before explained, this process is not as delicate a one as if the ingot were solid. The heat affects the center equally with the exterior and the two expand together and the danger of cracking is not incurred. When the ingot is reheated a steel mandrel is put through its hollow center, and subjecting the two to hydraulic pressure the metal is forced down and out over the mandrel. Thus an internal anvil is practically inserted into the forging and there is, therefore, really much less than one-half the amount of metal to work on than if the piece were solid.

When the work of shaping is completed the forging is reheated to the proper temperature and then either annealed in the usual manner or plunged into a tempering bath of oil or brine to set the fine grain permanently that has been established by the reheating. A mild annealing follows, to relieve any surface strains that may have been occasioned by the rapid cooling.

Hollow forgings oil tempered and annealed are considered the best grade of forgings made, and any forgings made otherwise, although they may be suitable for the service to which they may be applied, cannot be looked upon in any other manner than as of an inferior grade.

That steel forgings of such high grade were being manufactured for commercial purposes in this country was first brought to the attention of manufacturers generally at the World's Fair in Chicago. Here were exhibited stationary engine forgings which compared favorably with those sent over by European forges. The Ferris wheel shaft, 45 feet long and 32 inches outside diameter, with a 16-inch hole through it, represented the largest shaft made up to that time. The soliciting of orders for such forgings, however, at once aroused the latent prejudice still existing against steel forgings, and the prices demanded being somewhat in excess of those which wrought iron or ordinary steel forgings could be obtained for prevented at first the very rapid introduction of this product into the commercial field.

Difficulties Encountered in Introducing High-grade Forgings.

It hardly seemed necessary to explain to an engineer or any one authorized to purchase, and therefore presumably competent, that if he wanted material to sustain severe usage in the nature of alternating stresses, to which all forgings are subjected, he should select a material possessing a very high elastic limit. And yet it was not unusual to find that those very people preferred to use wrought iron for their engine crosshead and crank pins and shafts in preference to steel, because, as they said, "steel being crystalline is brittle and snaps off suddenly under such services as that under consideration, while iron, having fibre, is tougher and yields before breaking." Most of these men knew better, but had not given the subject sufficient thought or they would have perceived that their statements were not consistent. They said that the steel connecting rods they had tried had broken off short without any warning, while rods made of wrought iron had simply bent up, and after having been straightened out were replaced as good as new.

These people did not stop to think that a steel rod that broke off short had done so at its ultimate strength or under a stress of from 80,000 to 90,000 pounds per square inch, whereas the iron rod which had doubled up had done so at its yielding point of 25,000 to 30,000 pounds per square inch. In other words, their engines with wrought iron rods were failing all over the country under loads about one-third what they were standing up to when supplied with steel rods, yet the men were blaming the steel for helping them out of their troubles.

Then again they complained that steel shafts and crank pins heated up, while wrought iron ran cool. When it was proved to them that laboratory experiments showed the coefficient of friction of these metals to be the same and that any difference in heating was caused by local circumstances, such as poor lubrication, excessive pressure, etc., they said they did not care for laboratory experiments. They had an engine in one place with a steel shaft that never would run cool, while another with a wrought-iron shaft had never given any trouble, and they were passing judgment on their own experience. Persistent exposure of these fallacies gradually brought about a change in sentiment.

"Cold Crystallization" does not Occur.

It took a long time to persuade people who had seen broken forgings which showed a coarse crystalline section that the metal had not crystallized from shock or vibration in service, but had been forged in such a manner that the crystalline condition of the ingot from which the forging had been made had not been changed by the forging process or by subsequent heat treatment. And these are the people even now who consider themselves conservative, who would rather have their forgings made of a mild steel which is weak than of a higher carbon steel which is strong, simply because the old ideas are not yet eradicated from their minds. Tests were made at the Government testing bureau at Watertown by rapidly bending bars forward and backward within their elastic limit with the following results, and these have given engineers an idea of the comparative endurance of wrought iron, steel and nickel steel, in such service as that to which crank pins, shafts, etc., are subject:

TESTS OF STEEL UNDER REPEATED STRESSES.

Under a Fiber Stress of 40,000 Pounds per Square Inch.

Wrought iron breaks after	50,000	alternations of stress
.15% carbon steel “ “	170,000	“ “ “
.25% “ “ “ “	229,000	“ “ “
.35% “ “ “ “	317,000	“ “ “
.45% “ “ “ “	976,000	“ “ “
$3\frac{1}{4}\%$ nickel steel carbon .25 to .30%	1,850.000	“ “ “
$4\frac{1}{2}\%$ “ “ “ .25 “ .30%	2,360,000	“ “ “
$5\frac{1}{2}\%$ “ “ “ .25 “ .30%	4,370.000	“ “ “

---

* Extract from paper read by H. F. J. Porter, before the Engine Builders' Association.

Engineers and those whose duties it is to purchase forgings have been led to see that they should specify definitely the strength that they wish the material to possess and then to follow up the specifications by inspection to insure receiving what has been ordered.

During the past few years a series of specifications has been drawn up and adopted by the International Association for Testing Materials, which is composed of engineers, manufacturers, companies, associations, societies, and any individual or organization interested in obtaining standards. The standard specifications for forgings are herewith given for convenient reference and the physical properties mentioned are obtained from test bars drilled from a full-sized prolongation, forged to one end of the forging, these test bars being of the United States Navy standard size, ½ inch diameter and 2 inches long between gage marks.

REQUIREMENTS AND GUARANTEES FOR STEEL FORGINGS.

Class of Steel Forging		Tensile Strength, lbs. per sq. in.	Elastic Limit lbs. per sq. in.	Elongation, per cent.	Contraction of Area. per cent.
Nickel Steel.	(1)	95,000	65,000	21.00	50.00
Oil Tempered	(2)	90,000	60,000	22.00	50.00
	(3)	85,000	55,000	24.00	45.00
Nickel Steel, Annealed.	(4)	80,000	50,000	25.00	45.00
	(5)	80,000	45,000	25.00	45.00
	(6)	80,000	45,000	24 00	40.00
Carbon Steel, Oil Tempered.	(7)	90,000	55,000	20.00	45.00
	(8)	85,000	50,000	22.00	45.00
	(9)	80,000	45,000	23.00	40.00
Carbon Steel, Annealed.	(10)	80,000	40,000	22.00	35.00
	(11)	75,000	37,500	23.00	35.00
	(12)	70,000	35,000	24.00	30.00

Dimensions of solid and hollow forgings in which the physical qualities mentioned in the above table are guaranteed:

(1) Solid or hollow forgings, no diameter or thickness of section to exceed 3 inches.

(2) Solid forgings of rectangular sections not exceeding 6 inches in thickness, or hollow forgings, the walls of which do not exceed 6 inches in thickness.

(3) Solid forgings of rectangular sections not exceeding 10 inches in thickness, the walls of which do not exceed 10 inches in thickness.

(4) Solid or hollow forgings, no diameter or thickness of section to exceed 10 inches.

(5) Solid forgings, no diameter to exceed 20 inches, or thickness of section 15 inches.

(6) Solid forgings over 20 inches diameter.

(7) Solid or hollow forgings, no diameter or thickness of section to exceed 3 inches.

(8) Solid forgings or rectangular sections not exceeding 6 inches in thickness, or hollow forgings, walls of which do not exceed 6 inches in thickness.

(9) Solid forgings of rectangular sections not exceeding 10 inches thickness, or hollow forgings, walls of which do not exceed 10 inches in thickness.

(10) Solid or hollow forgings, no diameter or thickness of section to exceed 10 inches.

(11) Solid forgings, no diameter to exceed 20 inches or thickness of section 15 inches.

(12) Solid forgings over 20 inches in diameter.

* * *

SAVING FROM NEW TOOLS AND METHODS.

At a meeting of the Western Railway Club Mr. M. K. Barnum gave illustrations of the amount of money that is wasted every day by the lack of up-to-date tools. He contends that if an old machine can be replaced with a new one which will do enough more work, or do the same work with enough less labor, to represent a saving in money equal to 5 per cent. per annum on the investment, it should be entitled to careful consideration. As this is the basis on which other railroad improvements are figured, how easy ought it to be for mechanical men to obtain approval on a requisition for a machine which will save from 10 per cent. to over 100 per cent. per annum on the investment.

Several examples were instanced by Mr. Barnum of the saving through new tools and methods, which are given below. They are from "actual practice."

1.—In a railroad shop employing about 160 machinists there were no horizontal boring machines for such work as boring driving box brasses, rod brasses, rocker boxes, air pump cylinders, etc., and all such work had to be done in lathes, milling machines or drill presses.

After repeated conferences and much argument accompanied by estimates of savings that would result, permission was obtained to order a No. 2½ horizontal boring and drilling machine with 4-inch bar and latest attachments. It has been in use about 18 months and shows earnings by money saved as follows:

Original cost of machine installed ready for work..	$1,696.00
Average savings per year as compared with old manner of doing same work	900.00
Interest on investment	53 per cent.

It formerly required three hours to bore a driving box brass for a 9 x 12-inch journal in a milling machine and about four hours to do the same work in a lathe, whereas they are now bored in one hour in the horizontal boring machine. Rocker boxes, tumbling-shaft boxes, etc., are done in one-half the time formerly used.

In boring air pump cylinders it was formerly necessary to take the pump apart and set and bore each cylinder separately, requiring from two to three hours each. In the new machine it is possible to bore all four cylinders of a New York pump at one setting, without taking them apart, which requires but an average of one hour for each cylinder. In addition to the saving in time, much greater accuracy is insured. It is very conservative to say that this machine does double the work of the old ones, thereby saving the wages of one machinist at $3.00 per day for 300 working days, or $900.00 per year.

2.—An old car-wheel borer was replaced by a new, heavy 42-inch borer with hub-facing attachment, power crane for handling wheels, etc., which cost, installed, $1,710.90. This wheel borer saves the wages of one helper three hours a day and does more than double the work of the old machine, making a total of $2.45 per day, or $735.00 a year, which amounts to 42½ per cent. on the investment.

3.—A new heavy double head car-axle lathe, costing $1,665.00 installed, turns out one-third more work than the old one on account of taking a heavier cut and heavier feed, thereby saving about $250.00 a year, or 15 per cent. on the principal.

4.—It formerly required about four hours for eight men with screw jacks to take a 10-wheel engine weighing 132,000 lbs. off its drivers, at a cost of $5.14, and about one-half that time for four men to do the same work with hydraulic jacks; but using four pneumatic jacks, it is now regularly done by four men in one hour at a cost of 66 cents. However, to be strictly up-to-date an electric crane should be used and the time reduced to ten minutes.

5. A pneumatic ram was recently made at a cost of $168.55 for breaking staybolts to remove worn-out fire boxes, which earns very large interest on the investment. It formerly cost $45.60 to cut out the crown bolts and staybolts of a 10-wheel locomotive with 9-foot fire box, using three men, but with the pneumatic ram it is done by two men for $15.20, thereby saving $30.40 on each fire box. If only one fire box was removed each year this tool would earn 18 per cent. on the investment, but as this shop applies 30 new fire boxes a year the saving amounts to $912.00, or 541 per cent. per annum on the amount invested.

6.—In a certain shop which makes general repairs to about 160 locomotives a year the average length of time required to put each engine through the shop was reduced from 34 days in 1898 to 30 days in 1900. This represents a saving of 640 days for one locomotive, which, at a rental value of $10.00 a day, gives $6,400.00. As this was done with the addition of only a few new machines in a shop full of old and worn-out tools, many of which had been in service from 25 to 35 years, you can readily understand how much greater saving could be effected had the shop been fully equipped with up-to-date machinery.

* * *

The hottest place (on earth) is said to be at Mammoth Tank, Colorado desert, where the temperature has risen to at least 128 degrees.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY
Design—Construction—Operation.
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
9-15 MURRAY STREET, NEW YORK CITY.
CHICAGO—1462 MONADNOCK BLOCK. BOSTON—620 ATLANTIC AVE.
PHILADELPHIA—MACHINERY FLOOR, THE BOURSE.

SUBSCRIPTIONS.
SHOP EDITION, $1.00 A YEAR. TEN CENTS A COPY.
ENGINEERING EDITION, $2.00 A YEAR. TWENTY CENTS A COPY.
FOREIGN EDITION, $3.00 A YEAR PREPAID.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1902.

NET CIRCULATION FOR SEPT., 1902,—26,185 COPIES.

The index to volume eight of MACHINERY is now ready for distribution and will be sent to any reader upon receipt of postal card request.

* * *

With the establishment of the Engineering Edition of MACHINERY there is more room available in the dollar, or Shop Edition, for letters and short articles upon shop methods and devices and kindred subjects. Much of the general matter, such as has occasionally been published in MACHINERY, will now be transferred to the Engineering Edition, which will give additional space in the Shop Edition for articles dealing directly with shop practice. We intend to have these articles in greater variety than ever before, and readers of MACHINERY can materially assist in this by giving us the results of their experience and observation in the form of brief contributions, accompanied, if possible, by sketches or photographs. For the benefit of those who have not contributed, we will add that all sketches are redrawn in the process of engraving, no matter how good or how poor they may be, and that manuscripts are re-written in this office if necessary. While manuscripts and sketches should always be prepared as carefully as possible, a contribution will not be rejected simply because it needs considerable revision. It is the *idea* that we want, and if the idea is a good one it will always have careful consideration. All accepted contributions are paid for upon publication. There is probably not a machine shop in the land but that might supply something of value to many of our readers. All live mechanics are interested in something pertaining to shop work, and it is this something that we want to hear about.

* * *

BLACK DIAMONDS FOR USE IN THE ARTS.

Some months ago the writer visited a well-known shop in Brooklyn (National Meter Works) and was shown some interesting examples of the use of black diamonds or carbons for lathe and other machine tools. Some of the working parts of water meters built by this company are made of hard rubber, which has to be machined after being molded. It will probably surprise some mechanics who have never worked this stuff to learn that it is one of the most difficult substances known to machine with steel tools. In fact it is impossible to work it accurately with ordinary steel tools, or any steel for that matter. Some peculiar property of hard rubber, developed by the combination of ingredients necessary for vulcanizing, causes it to blunt the edge of the finest and best steel so quickly that it is rarely possible to go over the surface of a small piece even and have it pass the inspectors' limit gages, the wear of the tool being so great. Consequently it is necessary to use diamond tools for turning hard rubber and they are generally used for this purpose.

In these shops, however, the use of carbon tools has been extended to the regular machine shop departments, making them the finishing tools for turret lathes, for boring gas engine cylinders, and for many other purposes to which ordinary steel is usually applied. The results in the matter of accuracy are very gratifying and if it were not for two or three drawbacks the black diamond tool would undoubtedly become a common lathe tool accessory in many machine shops once its advantages were recognized.

One difficulty is that of holding an irregular mass of carbon so as to present the cutting edge advantageously and still hold it firmly enough to prevent its being dragged out by the pressure of the cut, and lost; but this is not very serious, since the proper function of a diamond tool is finishing and not removing heavy stock. There are a number of methods employed for mounting carbons in holders, the particular one to be used depending somewhat on the size and shape of the carbon and the use to which it is to be applied. Another and more serious trouble is grinding the correct shape of cutting edge for metals. This takes considerable time; again the grinding of carbons is said to be a trade secret not known to many of the regular cutters who work on white diamonds. The most serious drawback to the use of diamond tools, however, is their great cost. It is so great that it renders their use practically prohibitory except where the nature of the substance makes them positively necessary. This condition vitally affects the prosperity of a number of industries. Diamond dies are largely used for drawing the finer wire sizes and the diamond drill is extensively used in prospecting when it is desirable to secure a solid section of rock from depths.

The only place in the world in which black diamonds are found in sizes large enough to be of commercial value is in the state of Bahia, Brazil. A recent report made by Mr. H. W. Furniss, U. S. Consul at Bahia, Brazil, makes public considerable interesting information regarding the mining of diamonds and the reasons for the excessively high prices that prevail. Mr. Furniss says that contrary to what is generally believed to be the case, there is no combination of interests or syndicate that controls the output of carbon; the limited supply and consequent high prices may be attributed to the lack of proper machinery for mining.

Diamonds were first discovered in Bahia, Brazil, in 1821, but it was not until 1844 that they were mined to any extent. All diamond and carbon-bearing lands belong to the State, but it is possible for a person of any nationality to take out mining claims by complying with the State regulations, which do not appear to be rigorous. The climate, however, is very bad, fevers and other diseases being prevalent. The miners do not work systematically and the character of the tools used is very crude. Diving machines are used to a limited extent to get the precious stones from the river bottoms, and naked divers also work these beds. The geological formation of the district is volcanic. The diamonds are found in sandstone pebbles containing a very hard matrix. These pebbles are mixed throughout the granite and when exposed to the weather they disintegrate and expose the diamonds and carbon hidden within. The quantity of the granite containing diamonds is enormous and the production could be multiplied many times provided proper machinery and modern methods of mining and handling rock were employed.

The present output of carbon from the diamond district averages about 2,500 carats per month of all classes—porous, crystalline and good. The most valuable sizes are those weighing from one to two carats. Larger sizes have to be broken up to be used, which causes loss; and the smaller sizes are not in great demand. The largest black diamond ever found was discovered in the Lençoes district (where the best ones come from) in 1895. It weighed 3,150 carats and sold to the exporter for $24,500. The next largest in size was found in the same district in 1901 and weighed 577 carats. This was sold by the miner for $17,380. The average size of carbons is six carats. Almost the entire product of diamonds and carbons is shipped to London and Paris.

DANGER FROM GAS EXPLOSIONS.

The formation of explosive gas is a danger that cannot be too well guarded against as it often occurs in the most unlikely places and under what may seem to be normal conditions. We are, of course, only too familiar with danger arising from gasoline and benzine vapor. A tank full of gasoline is not nearly so likely to explode when approached by a light as when partly full or as an empty barrel which has contained gasoline, but an explosion in an empty steam boiler, is another matter. The *Locomotive* tells of an engineer at Menominee, Mich., who was severely injured by an explosion in an empty steam boiler which had been laid up for repairs. The repairs had been made and the engineer found it necessary to open a hand-hole to examine the interior. Finding it necessary to insert a candle, he did so and thrust it into the open handhole. Immediately an explosion occurred, accompanied by a blinding flash and loud report. The explosion appears very mysterious on the face, but it is attributed by the *Locomotive* to the use of petroleum or kerosene to loosen scale. Whenever a boiler is opened after such solvents have been used, great care should be taken to thoroughly ventilate the interior before inserting a light. A still more puzzling class of explosions is reported to have been occurring recently in the wheat fields of Washington. Many grain threshers have been wrecked and burned by gas explosions taking place while threshing. These were at first attributed to smut in the wheat, but it is pointed out that smut is no more plentiful this year than in former years. Apparently a more likely cause is the use of California petroleum for lubricating oil, which has been the practice lately. A hot bearing would, of course, gasify the petroleum and give off an explosive vapor which would only require a spark from the engine to cause an explosion. In fact the heat of the bearing alone might be sufficient.

* * *

NEW VARIABLE SPEED MOTOR FOR RAILWAYS

What may prove to be the most important event of the month in the field of constructive engineering is the announcement by the Westinghouse Electric and Manufacturing Co. of the perfection of an alternating current traction system for interurban railroads. A road with this equipment is to be constructed between Washington and Baltimore, a distance of 40 miles, with a branch running to Annapolis, a distance of 15 miles, by the Washington, Baltimore and Annapolis Electric Ry. Co.

For operating the ordinary street railways at the present time the direct-current motor is used, almost without exception. Where the distances traversed are great, however, the plan is sometimes adopted of using high-voltage alternating currents for distributing the power to points along the line; and then, by means of transformers and rotary converters, the current is supplied to the trolley wire as direct current at the usual railway voltage of from 500 to 650 volts. The rotary converter substation, however, has always been an undesirable feature, chiefly on account of the cost of the apparatus and building and the attendance required. While the plans that have been proposed to do away with this are numerous, none have appealed to railway engineers.

In Europe the polyphase induction motor has been used to some extent, but it has required the use of two or three overhead wires, and we understand that the induction motor has not been found entirely satisfactory in points of starting torque and in efficiency at other than the normal speed. The Westinghouse Company propose to employ a single-phase alternating current, to be transmitted at 15,000 volts to substations containing stationary transformers at suitable intervals. From these stations current will be fed to a single trolley wire at 1,000 volts. The motor used will be a single-phase, variable-speed motor, and it is in this motor and its connections that the greatest interest is attached. Particulars are not yet to be had, but the builders are confident that it marks a long step in advance, which has been awaited by railway engineers.

Two months ago we called attention to the electro-pneumatic car system recently perfected by Mr. Bion J. Arnold, Chicago, for the use of alternating current on railways. In this case the motor on the car is employed to propel the car and to charge an air reservoir on the car. The air compressor operates either as a compressor or motor, and is connected directly to what corresponds to the stator of an alternating-current motor, the stator in this case being so constructed that it can rotate instead of remaining stationary as usual. The speed variation in the motor is obtained by varying the speed of the stator through running the air engine at different speeds. The rotor, which drives the car, must necessarily keep in step with the stator and so propel the car at the corresponding speed.

The Arnold system is to be applied to an important line in the West, and this, with the Westinghouse line between Washington and Baltimore, may mean the beginning of a rapid change from steam to electric locomotives on suburban lines and even on through lines, where the conditions are suitable.

* * *

NOTES AND COMMENT.

REVIEW OF CURRENT EVENTS, TECHNICAL AND MECHANICAL.

In the article on the Cincinnati Machine Tool District in the September paper the total floor space of the G. A. Gray Co. was given as 30,000 square feet, whereas it should have been 70,000.

Probably the largest elevator contract ever awarded was recently closed by the Otis Elevator Co. with the Metropolitan Life Insurance Co., for the additions to their building, Fourth Ave., 23d and 24th Sts., New York City. The new equipment consists of 23 high-pressure passenger elevators, 4 hydraulic freight elevators and 2 electric passenger elevators and they contemplate converting the 13 passenger elevators in the original building, so as to operate them at an increased pressure. The plant, when complete, will consist of 40 hydraulic elevators, operated from one pumping station.

A bridge which will have the longest span in the world is being constructed over the St. Lawrence River six and one-half miles south of Quebec. At this point the river is from 1,900 to 2,500 feet wide, according to the tide. The channel will be crossed with a suspended span and two cantilever structures, the latter supported on piers near the shore, and having arms 500 feet long. The span from pier to pier will be 1,800 feet long, and the total length of the bridge will be 3,300 feet. The span of this bridge is nearly 100 feet longer than that of the famous Forth Bridge, Scotland, and 200 feet longer than that of the Brooklyn Bridge. The longest cantilever bridge in America at present is the one over the Mississippi River at Memphis, Tenn. It measures 790½ feet between supports. Another one is building over the Monongahela River, Pittsburg, for the Wabash Railroad, which is to be 812 feet long.

NOVEL EXPERIMENT IN "INDUSTRIAL BETTERMENT."

The J. A. Fay & Egan Co. and the Lane & Bodley Co. are planning the erection of a building upon the site of their Bond Hill factories for the benefit of the workmen employed. This will be something in the nature of a combined boarding house and restaurant, and the purpose is to so conduct it that it will take the place of the usual saloon and boarding houses which spring up in the neighborhood of large manufacturing establishments. Everything offered by the saloon will be offered here, but in a more attractive way, and it is the intention to sell everything at a price so much less that no ordinary saloon in the neighborhood can possibly compete. The companies expect to derive a benefit by securing abundant labor of the class which patronizes boarding houses by offering attractive rooms and meals at a cost much less than the workmen could otherwise secure.

PROGRESS ON NEW BROOKLYN BRIDGE.

It is now expected that the new Brooklyn bridge will be completed one year from the present date. All of the steelwork of the Brooklyn approach has been erected, the foundations for the Manhattan approach have been laid and considerable of the steelwork put in place. The stringing of the wires for the four main cables was completed several weeks ago. Each cable consists of 37 strands having 208 wires, .192 inch diameter and of 7,000 pounds tensile strength. This gives a total ultimate strength of each cable of 7,000 × 208 × 37 = 53,872,000 pounds, assuming that all the wires are strained equally when the cables are loaded. The greater part of the steelwork for the bridge proper remains to be manufactured, or put together at the plant of the Pennsylvania Steel Co., who are doing this part of the work; but they are required by contract to finish it within eight months from the time the cables are finished, and these, with the saddles for supporting the suspender cables, are now practically complete.

REMARKABLE PATENT CASE.

A dispatch to the *New York Commercial* states that every rolling mill in the United States rolling ingots into structural shapes is infringing on the patents of John Brisbin, a janitor, and Antonie Vinnac, a roller. Brisbin and Vinnac, both rollers, invented part of the present system of carrying the ingot on a bed of rolls laterally and vertically, for which they received a patent July 20, 1886. They also secured an interest in a patent granted Patrick Hanley and Francis M. Ritchey November 16, 1886. Suit was brought against the Carnegie Steel Co., Ltd., for infringement of patents in May, 1897. Judge Buffington, of the United States Circuit Court, heard the arguments last spring. The Carnegie Steel Co.'s claim was invalidity of the patent and non-infringement. Judge Buffington held that in view of the great advance in the system of rolling structural shapes, those who have from an inventive standpoint brought about such advance should share proportionately in the gains thereof.

SINKING A LARGE WELL.

The Des Moines (Ia.) Water Co. have used a novel method for sinking a large well that is to form a part of a new water system. The well is 19 feet diameter by 35 feet deep. The character of the soil is such that the running water and the loose sand make it impossible to first dig the well and then wall it up with brick; so the circular brick wall for the well was first built upon the dry ground, and, by cutting the dirt and sand out from underneath, the whole structure was gradually lowered into position.

An iron ring 35 feet in diameter, and triangular in cross-section, with one of the angles of the triangle pointing downward, was used as the foundation for the brick wall. This iron shoe weighed 5½ tons and on top of this was laid the circular brick wall with iron stay rods at frequent intervals to make it firm. This structure first stood on the surface of the ground, but by digging out on the inside the wall was forced down into the ground by its own weight. The weight of the shoe and brick wall together was about 150 tons.

THE HARVESTER AND SEWING MACHINE COMBINATIONS

And now the humble farmer and hard-working housewife are to come under the bane of the iniquitous trust. Five of the harvester companies of the country have merged into one corporation, called the International Harvester Co., and it is announced that a large corporation is about to be formed for the purpose of taking in nearly all the sewing machine manufacturers of the United States. The International Harvester Co., as given in the *Iron Age*, includes the McCormick Harvesting Machine Co., the Deering Harvester Co., the Plano Mfg. Co., the Warder, Bushnell & Glessner Co., and the Milwaukee Harvesting Co. The sewing machine firms included in the other combination, as stated in the *New York Times*, are the manufacturers of the New Home, Household, Domestic, Demorest, Standard, White, Davis, and National machines, the Williams Mfg. Co., Foley & Williams Mfg. Co., the Illinois Sewing Machine Co., and Chicago Sewing Machine Co. The Walter A. Wood Co., D. M. Osborne Co., the Acme Harvester Co., and several smaller firms are not to enter the harvester combination. Of the sewing machine manufacturers the Wheeler & Wilson, Singer, and Wilcox & Gibbs companies are, among others, to continue along independent lines.

A GOOD WAY TO SECURE AN UP-TO-DATE EQUIPMENT.

The Lane & Bodley Co., Cincinnati, O., are planning to build a foundry, primarily for their own engine business, and secondarily as a general jobbing foundry. Preparatory to beginning operations they have adopted a plan which other firms contemplating new structures might profitably follow. They have issued a form letter to the foundry trade calling for information relative to foundry appliances and the design of foundry buildings, of which the following paragraph contains the essential points:

"If there is anything profitable to be installed in a new foundry for our own standard work or for jobbing, we want to carefully consider, and if any provision should be made in the foundry arrangement or construction to adapt it to such profitable apparatus or appliances we want to know it before and not after the building is constructed. We inclose a blueprint indicating the proposed arrangement. If you build or have for sale anything you wish to suggest for installation in this foundry we shall be pleased to have a description, together with any alterations in the plan we send you, which you would suggest to better adapt it for your proposed apparatus."

NEW ELECTRICAL LABORATORY.

The buildings occupied by the electrical department at the Massachusetts Institute of Technology, Boston, have long been inadequate for the number of students taking the course in electrical engineering, and a new laboratory building is being erected which will have one of the finest equipments of any electrical laboratory in existence. In its appointments and variety of apparatus it will surpass the German laboratories, which, at the present time, probably rank the highest in scientific attainments and facilities for investigation. The laboratory will be divided into five important working parts—the power room and main laboratory; the smaller research rooms, based upon a study of the facilities which the Germans place at the disposal of special research workers; the standardizing room; the workshop, and the lecture room. These rooms, grouped in a single large building, covering some 40,000 square feet of land and one story in height, are so lighted by skylights that each has the steady, well-diffused light of an artist's studio. The lecture room will seat 300 students and facilities will be provided for bringing machinery into the lecture room, using it to illustrate the lecture and then for conveying it again to the proper place in the laboratory.

THIS YACHT IS WELL NAMED.

Charles R. Flint's steam yacht *Arrow*, designed by Charles D. Mosher, New York, evidently holds the world's record for high speed travel on the water. The *Arrow* was launched several months ago, and has been used by Mr. Flint in going to and from his business in this city. She was designed for a 40-knot boat, and it was expected that she would surpass in speed anything afloat. Not until recently, however, was a full power trial made. At the trial she attained a speed of 39.24 knots an hour, equivalent to 45.2 statute miles. This is two miles an hour faster than the speed claimed for the British turbine yacht *Viper*, the hull of which broke in two some time ago. Two of the fastest boats in this country are the *Ellide*, with a speed of 40 miles, and the *Porter* (torpedo boat) with a speed of 33 miles an hour. The dimensions, capacity, etc., of the *Arrow* are: Length, extreme, 130 feet 4 inches; length on waterline, 130 feet; beam, extreme, 12 feet 6 inches; normal draught of hull, 3 feet 10 inches; displacement, normal, 78 tons; coal bunker capacity, 17 tons; water tank capacity, 1,800 gallons. The horse power of her engines and boilers is about 4,000. The *Arrow's* hull was constructed by Samuel Ayres & Son, Nyack, N. Y., and the boilers were built at the Crescent Shipyard, Elizabeth, N. J. The L. Wright Machine Works, Newark, N. J., turned out the main engine and auxiliaries, and W. D. Forbes & Co., Hoboken, N. J., the air and feed pump.

WHERE SMOKE WAS A NUISANCE.

Since the installation of an electro-pneumatic switch and signal station by the Pennsylvania R. R. in Pittsburg for the operation of the switches and signals of the Pennsylvania lines east, the Allegheny Valley road, the Pittsburg,, Fort Wayne & Chicago, and the Pittsburg, Cincinnati, Chicago & St. Louis, which lines enter the new Union Depot in that city, it has been found that the black, cinder-like atmosphere interferes seriously with the operation of the new system. Frequent delays in the passenger service have been occasioned from this interference.

The compressed air power is supplied, for the operation of the switches and signals, from huge compressors in the main power plant of the station. When the trouble with the switches first occurred whole sections of the conduits were torn up and carefully examined, but no fault could be discovered. A number of leading engineers were then consulted, and it was finally discovered that the dense smoke from the trains and surrounding mills and factories was responsible for the clogging of some of the switches, and it was also found that the only way to prevent this trouble was to filter the air before its compression.

The company at once began the installation of an air filtration plant, and this plant, which is located next to the dynamo room in the power plant, has just been completed, and is one of the first plants of its kind to be installed in the country for railway work.—W. G. I.

THE GREAT SAULT STE. MARIE POWER PLANT.

During the past month water was turned into the recently completed power canal at Sault Ste. Marie, Mich., and one of the greatest water power enterprises of the country will soon be a reality. The canal utilizes a fall of about 18 feet in the St. Mary River, which connects Lake Superior and Lake Huron. An attempt to utilize this fall was first made on the Canadian side of the river in 1897, when a canal 2,000 feet long, 125 feet wide and 14 feet deep was completed with a capacity for 20,000 H. P. The new canal on the American side flows directly through the city of Sault Ste. Marie, and has double the capacity of the Canadian canal. It is about 2 1-3 miles long, has an average width of 224 feet and a depth of 22 feet. A large portion of the canal is cut through solid rock, and in its course through the city crosses thirteen streets, several of which have been spanned by steel bridges. At the lower end the canal widens out into the forebay, or more familiarly the mill pond, between which and the river into which the canal empties is built the power house. This is a structure 1,368 feet long, on pile foundations, with heavy masonry walls through which are the penstocks that will eventually supply water to 320 turbines of 500 H. P. capacity each. These turbines are arranged in pairs, two pairs, or four wheels, forming a unit and operating an independent shaft to which a 375-kilowatt generator is directly connected.

An interesting feature of the canal is a movable dam at the intake to control the volume of water. It consists of four leaves, 58 feet long and 28 feet high, suspended from and operating between piers of masonry. The enterprise has been conducted by the Michigan-Lake Superior Power Co., and about 20,000 H. P. will be used by the Union Carbide Co., who have a plant at Sault Ste. Marie for the manufacture of calcium carbide. The remaining power will be utilized for the reduction and concentration of the various copper and nickel ores found in the vicinity of Lakes Michigan and Superior as well as for general power purposes.

THE CANALS AT ST. MARY'S RIVER.

In commenting upon the opening of this canal the Dubuque (Iowa) *Telegraph* gives some interesting facts relative to the commercial development of the St. Mary River, which is indicative of the growth of American commerce. The St. Mary River is about 40 miles long and has a fall of 20 feet, making its ascent difficult to any except light traffic. The first attempt to improve the river was made about 1798 by the Hudson Bay Company, who built a lock 38 feet long, 8 feet 9 inches wide and 9 feet deep. The United States troops destroyed this in 1814. The ship canal on the American side was first proposed in 1837, and a canal 75 feet wide 10 feet deep and 100 feet long, with two locks, was commenced, but through difficulties with Federal authorities it was not completed. In 1855, however, a much larger and longer canal was built through the assistance of the government. Improvements were made in 1880 and 1896, greatly increasing the capacity of the canal, the traffic of which exceeds that of the Suez canal.

IN A CLASS BY THEMSELVES.

The Largest Dome in the World.

A hotel being built at West Baden, Ind., described in the *Engineering News*, will have the largest dome in the world, its span exceeding by about 15 feet that of the great dome of the Horticultural Building at the Chicago Exposition of 1893. This dome, which has a steel framework, is nearly 200 feet in diameter and rises 50 feet above its bed plates. The framework consists of twenty-four ribs connected to the center or crown by a circular plate drum and tied together at the bottom by circular plate girder ties. The weight of the dome complete with its outer covering is 475,000 pounds. It was designed and erected by the Illinois Steel Co.

The Largest "Automobile."

What has been described as "the largest automobile ever built" is a combined harvester and traction engine in use in Southern California. The big machine consists of a traction engine capable of hauling 75 tons, and which takes the place of 60 horses; a header or mowing machine, which cuts a swath of 36 feet, and a threshing machine all complete. The threshing machine and header are run by a 30 horse power engine entirely separate from the traction engine, save that they both get steam from the same boiler. The drive wheels are 8 feet in diameter and have tires 48 inches wide, on which are ridges 1½ inches high. Under the most favorable conditions the machine can thresh in one day the grain grown on 100 acres. Eight men are employed on the thresher. Oil is used as fuel, and four horses are employed to draw the oil and water required for the boiler as it travels over the plains.

The Largest Steamer in the World.

The largest steamship in the world to date is the Kaiser Wilhelm II., which was launched August 12, 1902. She was built for the North German Lloyd by the Vulcan Co., Stettin, Germany. The Kaiser Wilhelm II. is 706 feet 6 inches long, 72 feet wide, 52 feet 6 inches molded depth, 29 feet draft, and has a displacement of 26,000 tons. She has four sets of 4-cylinder quadruple-expansion engines, the total power of which is nearly 40,000 H. P. Two of the cylinders of each engine are arranged tandem so that a three-crank shaft is required for each engine. The cylinder diameters are 37.4, 49.2, 74.8 and 112.2 inches, all having a common stroke of 70.8 inches. Steam is supplied by twelve double-ended and seven single-ended boilers at a pressure of 225 pounds. The total heating surface is 107,643 square feet, and grate surface 3,121 square feet. The estimated speed is 23½ to 24 knots per hour. Accommodations are provided for nearly 1,900 first, second and third cabin passengers.

* * *

OBITUARY.

Albert F. Prentice, vice-president of Prentice Bros. Co., of Worcester, Mass., died on September 14, at his home in that city, aged 61 years. Mr. Prentice had been prominent in Worcester for many years and had worked his way from a journeyman mechanic to the proprietor of a large business. He was born in Worcester in 1841, and educated in the common and high schools of that city. With a brother, Vernon F. Prentice, he worked in the foundry of the Cleveland & Bassett Co. for a number of years, and then the two brothers engaged in the toolmakers' business. This business was finally sold to F. E. Reed.

In 1872 the brothers began the manufacture of blacksmith drills under the name of Prentice Bros. Later they built machine tools—lathes and drilling machines being their special product. In 1889 they erected the building they now occupy, and about that time the firm was incorporated into a stock company, with Vernon F. Prentice as president and A. F. Prentice as vice-president. Mr. Prentice was a member of various societies, social and industrial.

SUPERHEATING.

THE QUESTION OF VALVES—WATER IN THE CYLINDER—TESTS—THE SCHMIDT APPARATUS.

WM. H. BOOTH.

Superheating steam enables it to live and therefore to do more work than if it were not superheated; and as less fuel need then be used it follows that the tendency of expensive fuel is to help on the practice of superheating. To expensive fuel is probably due the continued use of superheat for many years past in Alsace, where through the labors of Hirn, steam economy has been made a special object. In countries with cheap fuel there is less inducement to employ superheat and the additional appliances involved. Moreover, when superheat *did* first come into vogue in Great Britain it was soon discarded, for two reasons. One was the inability of organic lubricants to live at all at the high temperature; the other was the growth of the compound system which enabled a large economy of fuel to be secured and in an easier manner than that of superheating. And all attempts at economy have, since about 1860 to the present day, been along the lines of higher pressures and more cylinders.

But mineral oils, graphite, better construction and experience have once more brought the superheater to the front. All attempts at steam economy, so far as the engine using the steam is concerned, resolve themselves into more or less direct means or efforts to preserve the cylinder as hot as the steam which enters it. To begin with there is the saving due to increased expansion. This economy failed at a very early point. It was found not to continue beyond quite moderate rates of expansion. The reason was that the cylinder was not hot enough: it chilled the entering steam and put a short limit on further expansion with economy. Next we might cite the Corliss valve with its sharp cut-off which was erroneously credited with the economy that certainly came with this type of valve. Present-day knowledge discredits both the sharp cut-off and the valve itself to some extent, and gives credit to the position of the valve and the use of separate valves for inlet and egress of steam. To the position of the valves is especial credit due, for steam valves were so placed that they shot the moisture that entered with the steam right across the cylinder into the exhaust port, whence it was promptly ejected as soon as the exhaust valve opened. In this way the water did not partake in the processes of re-evaporation at the expense of the heat in the cylinder metal which go on in cylinders less perfectly drained.

This thought raises the question of the position of Corliss valves in cylinder heads. With the exhaust valve raised above the lower side of the cylinder of a horizontal engine, the drainage cannot be so perfect and a fault may be here introduced that will wholly or in part negative the claimed benefits of smaller clearance spaces.

Means of Overcoming the Effect of Cylinder Condensation.

One need only assume that a minute thickness of the internal surface of a cylinder follows the temperature of the steam as this enters the cylinder, expands and exhausts at constantly varying pressure, to realize that there must be great interaction between the cylinder surface and the steam. Despite the specific heat of cast iron being only a fraction of that of water, its specific gravity, is so much greater, and the weight of steam that enters a cylinder is so small a fraction of the weight of the assumed thin sheet of cylinder surface, that this surface cannot change its temperature unless it absorbs a considerable quantity of heat from the entering steam, to give it up again to the water during the exhaust stroke. This water is formed by condensing the initial steam upon the cooled interior surfaces of cylinder and piston. In early steam engineering days men built a fire under the large cylinders of the huge Cornish mine pumps. Trevithick was accustomed, in his high-pressure engines, to place the working cylinder inside the boiler steam space and this was continued in many later locomotives. Drawings of Trevithick's locomotive of 1803, which ran from the Pen-y-dareen works at Merthyr-Tydfil in South Wales, show a horizontal cylinder inside the steam space. This was the first locomotive ever run on a rail.

Jas. Watt used the jacket to keep the cylinder as hot as the steam that entered it, to use his own expression, though of course it did not fully accomplish this desirable end. Watt must have seen clearly the effect of water in the cylinder, for he could not have been unobservant of the fact that the condensation was transferred to the jacket, yet economy resulted. This of course was because, from the jacket, the water drained away unevaporated and did not enter the cylinder and it is now recognized as good practice to carry the working steam by way of the jackets if these are so designed as to be well drained. Jackets not thus supplied are too apt to become dead ends of air or mere pockets of water. But the steam jacket can after all exert but a small effect on the steam in the cylinder. The heat of the jacket must travel through the cylinder wall and the inner skin of the cylinder will still change its temperature with the steam, alternately being hotter and colder than the steam within it and evaporating or condensing it accordingly. The net result of cylinder condensation is that the heat which should do work may be said to enter the cylinder wall, step down to a level of less potentiality and emerge at the lower level without having done mechanical work.

If the material of a steam cylinder were absolutely adiabatic, neither absorbing nor giving out heat, it would matter little at what speed it were set to run. The only matters affecting economy would be those connected with the internal frictional resistances of the working parts, and the clearance spaces and their treatment. The effect of these matters could easily and quietly be ascertained, and a level of performance and efficiency would be attained from which the best made engines would very slightly depart. It is to cylinder condensation we owe the jacket. The high rotative type of engine is an endeavor to minimize cylinder effects by cutting down the time that each charge of steam is exposed to the cylinder walls. At least this is the customary erroneous way of stating a half truth. It is not that the steam is exposed for so short a time, as that the cylinder metal undergoes oscillations of temperature of less amplitude than the steam. In a very slow-running engine the inner skin of the cylinder practically follows the steam in temperature; the rise and fall have no appreciable lag. At high rotative speed the undulations of the temperature become less in amount, lagging behind the steam curve. Obviously this must be so. At an infinite rate of rotation the cylinder wall temperature would be represented by a horizontal line at a mean height on the temperature diagram of the very slow speed engine and the effect upon the steam and water in contact with the cylinder would be minimized. Another effect of high rotative speed is that water produced as mist by the conversion of heat into work is carried off before it has time to settle upon the cylinder walls.

Compound engines are another means of combating the evil. By dividing the whole range of temperature between two cylinders the condensation is reduced. All that which occurs in the first cylinder appears as steam again in the second, except for the small amount which is converted into work or lost by radiation. All the steam that enters the first cylinder must appear as steam to enter the low-pressure cylinder. The total heat of the entering steam at the first cylinder is greater than the total heat of the same steam exhausting at a lower pressure and, so far as the effect of the high pressure cylinder is concerned, upon the steam which enters it. This steam when re-evaporated at lower pressure, not having done work must be superheated. If it were possible to preserve a cylinder from radiation losses, and remove the liquefaction due to work, the exhaust of the high-pressure cylinder of a compound engine would be slightly superheated. The compound principle probably gains something by the smaller periphery of pistons and valves that are exposed to boiler pressure and by the reduction of the pressure difference on opposite sides of these peripheries of leakage.

Why Superheating Leads to Economy.

When the causes of cylinder condensation are thus understood and the immense effect on economy is realized, it is easy to foretell the benefit to be derived from additional heat. Steam cannot be superheated in presence of water. Either the water will soon be licked up or steam will become saturated. By adding heat to saturated steam not in presence of water, the steam is first made more perfect by the more thorough separation of the last remaining molecules of what has hardly yet become true steam. This done the steam becomes superheated. Steam is so light a gas (only a little more than half the weight of air—about 3-5 actually) and its specific heat is less than half that of water, that it cannot carry much heat per cubic foot for even 100 degrees difference of temperature. We can therefore not explain the economy of superheated steam by any reference to the additional heat which it carries into the cylinder. If steam be superheated by 100 degrees, this only represents about 4.8 units of heat per pound of steam at most, and one pound of steam already contains 967 units of latent heat. The addition is but ½ of 1 per cent and the smallness of the amount of heat is proved by the rapidity with which superheat disappears. About 10 degrees are said to disappear for one meter length of steam pipe under ordinary conditions. It follows therefore that the explanation requires further consideration and it will be found, if we consider for a moment, that dry steam has a very poor heat absorbing effect. If for one stroke of a steam engine we could prevent the initial steam from condensing in the cylinder walls there would be no water to re-evaporate; and if there were no water to re-evaporate, the cylinder metal could not lose heat except by radiation to dry steam that would not rapidly absorb it. As a consequence the cylinder would still remain hot for the next charge of steam. Thus except for the small amount of heat lost to the dry steam, once heating up a cylinder to the initial steam temperature would be enough to stop condensation losses for the day. Once allow a mere fraction of steam to condense and at once the action recommences. Water accumulates until it reaches such a maximum that the exhaust valve prevents further cumulation. It follows that what is wanted is just enough added heat to reduce the cumulation of wetness to the opposite effect of cumulation of dryness. Thus, if we assume an engine to be running wet, that 100 parts of water are re-evaporated at each stroke and that there is added sufficient heat to bring down condensation to 90 instead of 100, the next stroke will find the cylinder cold only to 90-100 of its former degree of coldness. Continue the addition of heat and a third stroke finds only 80 of cooling and so on. In a short time the cumulation of effect will reach a maximum and the cylinder effect will remain constant at the new figure, but will be again reduced by further small additions of heat every stroke. Ordinary degrees of superheat do not produce a dry exhaust. Some cylinder condensation still goes on, but very great benefits will accrue, not the least of which is that due to the steam being dry.

The Schmidt System of Superheating.

During the past few years several superheaters have been placed before steam users, with more or less success. Amongst the more recent is the Schmidt system which embodies the use of very high degrees of superheat. Thus in some recent tests the steam arrived at the stop valve at 709 degrees F. for a pressure of only 129 pounds. The added temperature was thus 354 degrees F., the steam being almost exactly doubled in thermometric temperature. It does not, however, enter the cylinder at this temperature, but parts with some of its heat to the steam entering the low-pressure cylinder. This reduces it to 601 degrees. It leaves the intermediate cylinder at 286 degrees and enters the low-pressure cylinder at 397 degrees, acquiring 111 degrees of temperature from the initial steam which lost 108 degrees, thus apparently confirming the temperature readings very fairly. The low-pressure steam must have been highly superheated to begin with, for it only gave an indicated pressure of about 2 pounds initially in the third cylinder, corresponding with a temperature of about 219 degrees—so that it began 178 degrees superheated which is more than we are accustomed to see at the superheater in ordinary cases. The exhaust from the intermediate cylinder was 66 degrees superheated and the general appearance of the diagrams showed dryness throughout. There was none of the filling up of the toe of the diagrams that is so grave a fault with saturated steam and shows re-evaporation at the expense of the heat in the cylinder walls. Indeed, the diagrams seem to show that about 350 degrees of superheat can be dealt with in an engine, without either wetness supervening or the exhaust being too dry. The superheat represents an addition to the total heat above 32 degrees of just one-seventh or 14 per cent—or say, 15 per cent as measured above ordinary feed temperature, but it is nearly 20 per cent of the latent heat of vaporization of steam at the pressure named—130 pounds gage pressure. The steam used per indicated horse power was 11.4 pounds per hour, which curiously enough is about 20 per cent less than a good triple-expansion engine with plain steam. This appears to be merely a coincidence. If one can look for an economy of 20 per cent with a superheat of 354 degrees an approximation to the economy at other temperatures may perhaps be made by allowing an economy of, say, 5 per cent for absolute dryness of initial steam, and a further 1 per cent for each 25 degrees F. of superheat. In running engine tests for allotment of bonus or penalty for performance in steam per k.w. hour, it is not always possible to secure the conditions of the specification, and it is necessary to agree upon the correction to be made for difference of the vacuum or of the superheat in a way to satisfy both parties. Very little is really known about the influence of superheat. Hitherto we have been contented with 100 or 150 degrees and have seen half of this amount disappear between boiler or superheater and the engine, and have been able to feel assured of little except that we were getting dry steam.

In the Schmidt engine the steam used per unit varied from 38 pounds for an output of 20 k.w. down to 18.3 pounds for a load of 140 k.w. From this it would appear that the engine used about 460 pounds to keep itself and the dynamo running, and that each unit really required about 15 pounds of steam per hour per k.w. for output or about 12.6 pounds per k.w. of engine power or about 9½ pounds per horse power, with the addition of the 460 pounds per hour spread over the whole output. This amount, of course, is much more serious on small outputs and shows how uneconomical it is to underload an engine.

The following were the figures obtained at various loads:

K.W.	Steam per Unit.
140	18.3
120	18.5
100	18.7
80	19.4
60	20.8
40	24.5
20	38.0

The formula:

$$\frac{(\text{K.W.} \times 15) + 460}{\text{K.W.}} = \text{steam per unit},$$

will be found to work out very closely in correspondence with the above figures, which therefore lie upon, or approximately upon, a straight line curve.

The Schmidt Apparatus.

Coming now to the actual apparatus used to give superheat to steam Figs. 1 and 2, page 86, show the Schmidt superheater which has a peculiarity of construction that may be particularly noted. It is known as the countercurrent and concurrent system. First, the steam from the boiler enters at that point of the superheater furthest from the source of heat; and it travels through the superheater in a direction opposite to the plane of the hot gases, until it reaches about the middle of the superheater structure. Arrived there the steam is then taken to the hottest end of the superheater and travels again toward the middle point, this time in the same direction as the gases. This is claimed to prevent the hottest end of the superheater from burning out. There is a superheater much used in this country (England) which is so arranged that the steam is taken alternately through two superheater coils and through coils immersed in the water of the boiler; and there is excellent authority for a statement that even after this treatment the steam still remains superheated. Whatever may be the case, the system has been found to give very high results in steam production. A boiler could be forced to the point of heavy priming and in combination with the superheater give a total output of dry steam of even treble its normal duty. Numerous other superheaters are at work with fair satisfaction, but none have attempted the high temperatures of the Schmidt system.

Obviously these high temperatures need care. Before closing down the heat is kept out of the superheater and it is allowed to work about an hour on the stored heat from the brickwork and in case of sudden stop provision is made to let in cold air. My own experience of superheat points to the importance of blowing through a superheater before allowing it to supply steam to an engine, if there has been a short stoppage with hot fires. The steam, after such a stop, may go nearly red hot to an engine. Also in constructing an engine for high superheat certain points especially require to be watched. It may cause trouble to have a piston valve with its outer case carried by ribs that get hotter than the seating sleeve. Such a valve will seize on points coincident with these inner ribs. Long sleeves, to keep piston rods and valve spindle glands away from the hot steam are employed; and generally when designing an engine to use very hot steam, it is necessary to consider every detail and ask if it is exposed to any special expansion effect greater than surrounding parts.

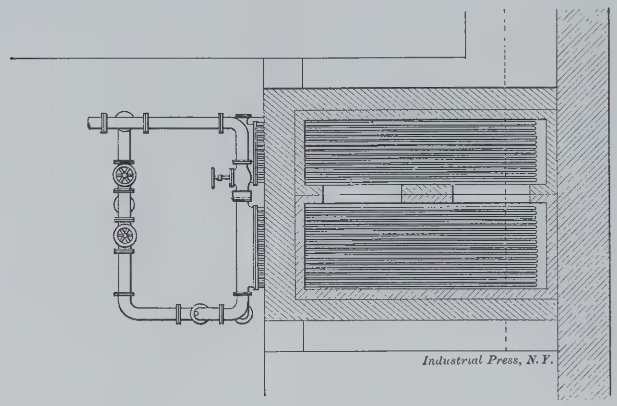


Fig. 1. Plan of Schmidt Superheater.

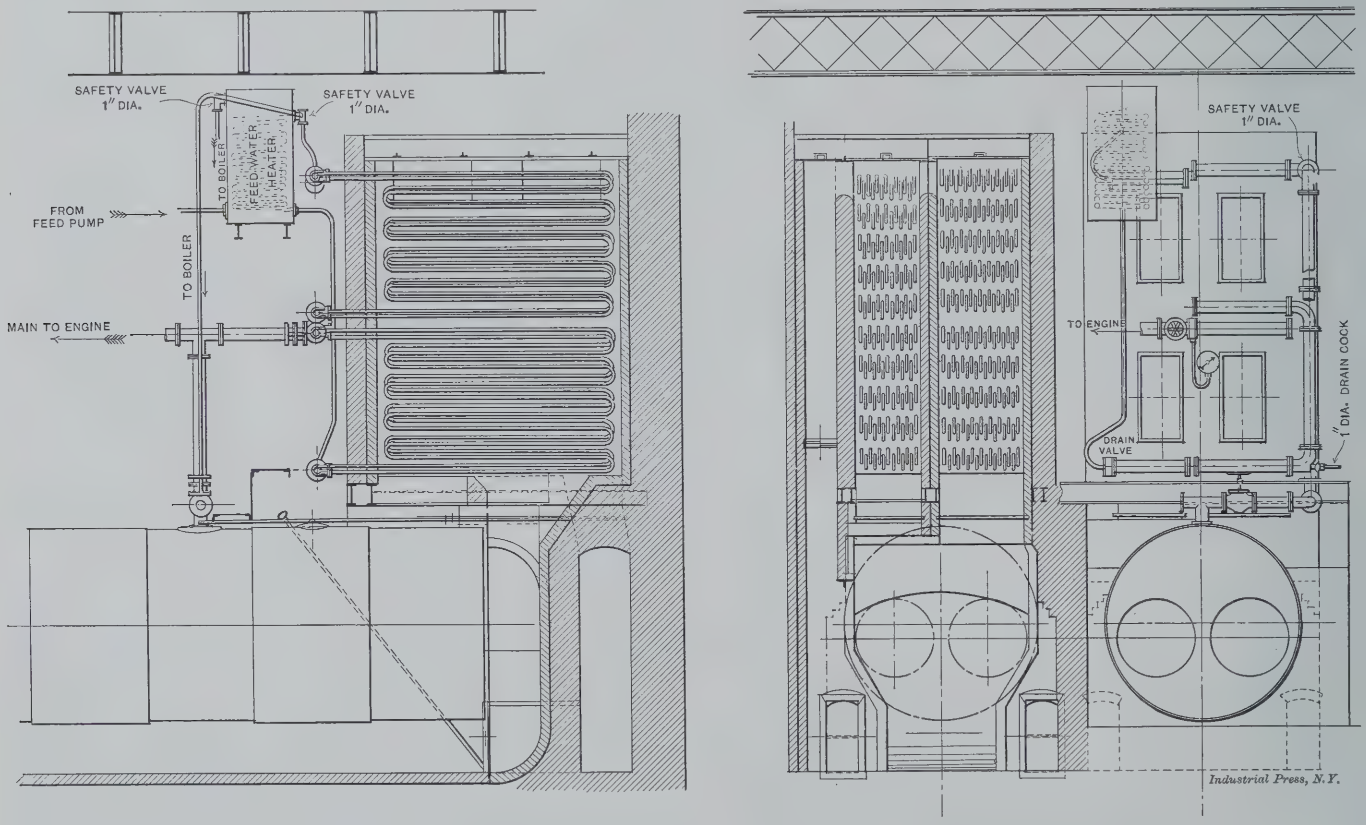


Fig. 2. W. Schmidt's Superheater and Economizer applied to a Lancashire Boiler.

In the foregoing I have taken the specific heat of steam as 0.48, but this seems very doubtful. The consensus of opinion, however, appears to be that it is not more than this figure and may be considerably less.

By means of superheat alone can a steam engine be made to approach its thermodynamic ideal. It seems likely that it will enable the triple-expansion engine to be replaced by the more simple compound or the compound by the simple engine. One thing is certain, that there would be very little difference in economy of one engine from another if it were not for the action of the cylinder metal. All electric traction men know that the very small load factors of tramways, especially of small systems of a few cars only, involve the use of steam engines which are double in size what they might be if not of the compound type. The compound engine *must* be large in order that it may take in steam enough at its first cylinder to turn its load. The first cylinder measures off the steam to the second and limits the power of the engine to what can be given by about three-fourths of a small cylinderful of steam per stroke. If by the aid of superheated steam the pernicious cylinder condensation could be checked in simple engines these could be made to give the maximum duty required without being underloaded at mean load. For the maximum load could be dealt with by three-fourths of a cylinderful of steam in the large (and only) cylinder and this could be, in cases I have calculated out, just about one-half the capacity necessary in a compound engine. The formula for steam per unit above given may be calculated out with the constant 460 and with a new constant of 230. The new constant will give much better results, especially at the smaller powers, for it represents the constant friction and radiation losses, etc., of the engine, and such losses are approximately in proportion to the size of the engine. A small engine properly loaded will in itself give better results apart from the frictional constant. I am of opinion that too much has been made of the compound principle for widely variable loads, for these compel a seriously small average load on the engine or it will not turn round at the minimum loads. Possibly by means of superheat the small single engine would do far better than the compound.

* * *

The Boston & Maine and the Boston & Albany railroads are to discontinue the practice of oiling their roadbeds to keep down the dust. While the remedy is efficacious so far as dust is concerned, there are many complaints from passengers whose clothing has been soiled because of the practice. When particles of sand and dust on an oiled roadbed are dislodged by a passing train, they are quite likely to leave an oil spot wherever they fall.

AN ADJUSTING MOTOR.

INTERESTING MECHANISM FOR STEERING GEAR AND OTHER PURPOSES.

In a recent article on marine steering gears attention was called to the fact that the engine should keep in motion only while the controlling valve is being operated upon by the steering wheel or lever, and as soon as this ceases the valve should automatically return to its mid position, while the piston immediately becomes locked in whatever position it may chance to be. It is for the accomplishment of this purpose that the controlling motor here illustrated was designed by Mr. Lincoln A. Lang, of Yale, N. Dak. This motor is not only applicable to marine steering purposes but may be used for steering motor vehicles, for controlling engines, operating power feeds, presses, etc. It may be operated by steam, compressed air, or liquid under pressure, but for steering purposes an elastic medium like steam or air is preferable on account of the liability to shocks.

The general arrangement of the motor is shown in Fig. 1. Working in a cylinder is the piston V from which piston rods extend through front and back cylinder heads and each connects to a cross-head, one of which is shown at J. A secondary cylinder or steam chest is located above the main cylinder and has connection with it by means of the ports C C'.

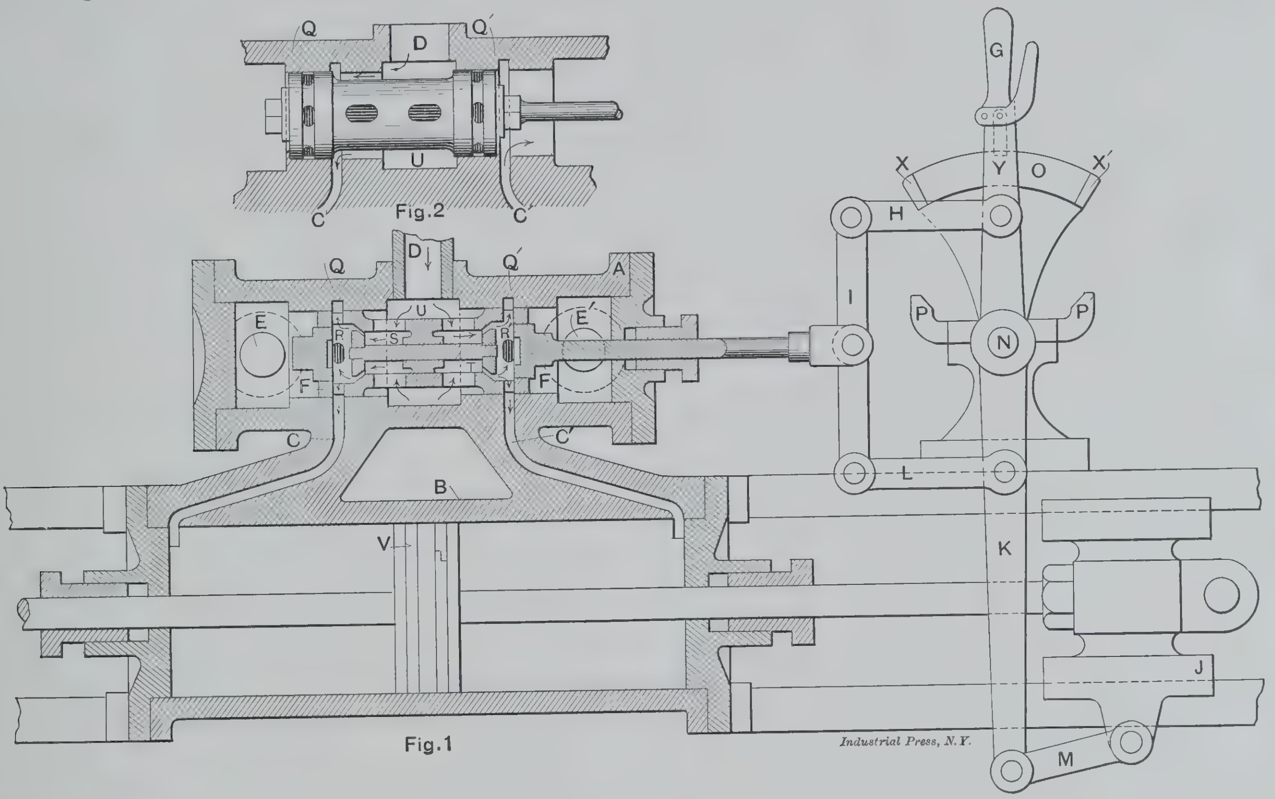


Fig.2

Fig.1

Lang's Adjusting and Controlling Mechanism.

This steam chest connects with the source of motive supply by means of the pipe D, and with the atmosphere by the pipes E E'. Working within the steam chest is the hollow piston valve F, which is actuated primarily by means of the hand lever G, the link H and the floating lever I; and secondarily by means of the cross-head J, acting through combining lever K and links L and M. The sector O and the combining lever K are integral and swing from the fixed pin N, while the lever G is mounted independently upon the same pin and is limited in movement, primarily by the stops X X' on the sector and ultimately by the fixed stops P P'.

The movable sector O is provided with a central notch Y which is adapted to engage a spring catch upon the hand lever so that lever and sector may be locked together. The hollow piston valve F is closed at both ends and its interior communicates at all times with the source of motive supply by means of the openings, as indicated by the arrows. The circular grooves Q Q', Fig. 2, through which the steam enters the cylinder, are so located as to register exactly with the ports C C when the valve is in its mid position. Mounted loosely in the bearing S, within the main valve, is the independent double-ended check valve T which is adapted to close communication between either of the chambers R R' and the interior of the valve. Assuming the piston to be in its central position, then the motive power, entering the chest by the pipe D, passes through the valve and the ports C C' into both ends of the main cylinder, thus establishing an equal pressure on both sides of the piston. Now if some external force or shock is exerted upon the cross-head, tending to move the piston in either direction, the result will be a tendency of the motive agent to circulate, which acting upon the check valve T will cause it to seat instantly, thus shutting off any outlet for the motive agent and preventing the piston from moving. Since the check valve seats itself against generator pressure it cannot pound and will fall back naturally to the balanced position as soon as the force tending to move the piston ceases to act. If we wish to shift the piston to one side of the center, to the right for example, the hand lever G is unlocked from the sector and thrown over against the primary stop X, under which conditions the valve assumes the position shown in Fig. 2. This places the port C in direct communication with the live chest U and opens the port C' to exhaust, both ports Q and Q' being thrown out of operation. The piston now moves to the right and in doing so swings with it the combining lever K. This revolves the sector O to the left and at the same time actuates the lower end of the floating lever I so as to return the valve to its original mid position, which will stop the piston and lock it in its new position. In its movement to the left, the stop X has moved away from the hand lever, so that when the mid position of the valve is regained the hand lever is again central with the sector.

Had it been desired to continue the movement of the piston to the right the hand lever, instead of being held in place, would have been kept in contact with the stop X and caused to move with it to the left. This would have continued until the hand lever engaged the fixed stop P, when the movement of the levers would float the valve to its mid position and stop the piston just at the end of its stroke.

Thus by moving the hand lever to left or right we can cause a corresponding movement of the piston, the length of whose movement can be regulated by the length of time we hold the lever against the stop X or X'. Whenever the desired position of the piston has been reached it is necessary only to stop the motion of the hand lever, when the valve will at once assume mid position, locking the piston in place.

ENGINEERING REVIEW.

A SYNOPSIS OF CURRENT TECHNICAL LITERATURE.

MAKING LARGE THREADED PIPE JOINTS TIGHT.

American Machinist, September 11, 1902, p. 1315.

"We and others," says Prof. Sweet, "have had a great deal of trouble in making and keeping large threaded pipe tight. We find that by threading the flanges ¾ inch to foot taper and the pipe ⅝ inch to foot, the joints stay tight. The reason is that after being threaded the end of the pipe is thinner than farther back. The thin portion will compress as the thread is screwed home so that it fits closely all the way. Tinning the thread of a pipe before it is screwed in, is better than any paint or smear grease."

PENALTIES FOR DIVULGING TRADE SECRETS IN FRANCE.

Cassier's Magazine, September, 1902, p. 625.

Under a French law still in force, the communication by a factory workman, clerk, or manager, of a trade secret to a foreigner, or to a Frenchman resident abroad, is punishable with a term of imprisonment ranging from two to five years, and with a fine ranging from 500 to 20,000 francs. The culprit is, moreover, deprived of his civil rights, and kept under police surveillance for a period of from five to ten years after his release from prison. A similar communication made to a Frenchman resident in France, is less heavily punished, the term of imprisonment varying in this case from three months to two years, and the fine from 15 to 200 francs. In the case of a State arms or ammunition factory, the maximum penalty must be imposed. It appears, further, that in France the proprietor of a factory has a right, without reserve, to the discoveries and inventions made within his field of work by any of his employees.

THE HIGHEST RAILWAY IN THE WORLD.

World's Work, September, 1902, p. 2516.

On the Oroya Railway in Peru, known as the Ferro Carril Central del Peru, it is possible to leave a station in a tropical climate eight degrees south of the equator and in eight hours reach a region of perpetual snow and ice. This railway is probably the most wonderful in the world, considering the difficulties encountered in its construction and the engineering expedients adopted to overcome them. Its total length from Callao to Oroya is only 138 miles, yet it cost $43,000,000 to construct, or over $310,000 per mile. At Chosica, thirty-three miles from Lima, the first switch-back is located and from this point until the summit is reached, the grade is four per cent. The summit is in the middle of the Calera tunnel (which is one and one-half miles long), and is at an elevation of 15,665 feet above the sea. This elevation is on a level with the summit of Mont Blanc in Switzerland and 1,445 feet higher than the Pike's Peak in Colorado. The railway skirts the edges of precipices thousands of feet deep where it is difficult to understand how the surveyors laid out the route. In fact in many places it was necessary to suspend them by ropes as they worked. In one place the bed of the River Remac is usurped by the track of the railway, the river having been diverted by a tunnel so it flows beneath the tracks. A car will run by gravity alone from the tunnel to the sea coast, a distance of 106 miles. The road is standard gage. The fuel used on the locomotive is petroleum.

AUTOMOBILE FOR HEAVY DUTY.

Iron Age, August 28, 1902, p. 11.

The Fischer Motor Vehicle Co., Hoboken, N. J., are now manufacturing an automobile for heavy trucking which has a novel motive power in the combination of a gasoline engine with an electric storage battery. The gasoline engine, while it is a very convenient form of motive power, has but a limited range of speed and will not carry an overload. The storage battery, while overcoming these difficulties, is but a secondary power and consequently of limited mileage. The new motor is a combination of the two systems, possessing the advantages of both and eliminating the disadvantages.

Under the fore part of the vehicle is placed a 10 H. P. three-cylinder, four-cycle gasoline engine directly connected to a 5-kilowatt 110-volt dynamo. The current from this motor is used to drive a pair of 5 H. P. motors, one of which is connected by gear and pinion to each rear driving wheel. Between the dynamo and motors are placed 50 storage battery cells, having a capacity of 90 ampere hours. When the load demands, full current goes from the dynamo to the motors, but when from slowing up or any other cause less power is needed than is furnished by the engine the current is automatically taken up by the batteries, and when, in ascending grades or starting loads extra power is required, the batteries promptly supply the deficiency.

A test of this motor was made when the ground was covered with snow. A mileage of 54 miles was made with a consumption of 12½ gallons of gasoline. At 9 cents per gallon this makes the fuel cost a fraction over 2 cents per mile under the most unfavorable conditions.

PRACTICAL POINTS REGARDING COMPRESSED AIR.

Compressed Air, 1902.

The cooling of air during compression by injecting a spray of water into the air cylinder, has been generally abandoned for the multiple-cylinder compressor in which the air is compressed by stages with intercoolers between. Water injection is bad because it causes excessive wear on the pistons and cylinders, and because of the capacity of air to take up moisture when at a high temperature. The capacity of air for moisture is in direct proportion to its temperature. Dry stage compression gives a pressure line more nearly isothermal than the injection process.

The air supply for a compressor should never be drawn from the engine room. It should always be taken from the coolest source available and that is usually the outer air. Hot supply air means thin air, and that means low volumetric efficiency. The hotter it is the more power will be required to compress a certain volume to the required pressure. After compression the air should be cooled in a condenser to abstract the moisture. Air at all times contains moisture, the average moisture being 50 per cent of what is required to produce saturation. If we can cause this moisture to be deposited in the condenser or after-cooler, it saves having it deposited on the interior of the supply pipes. Often these pipes are covered with frost on the inside, sometimes to such an extent as to choke their capacity seriously. Again moisture in the air will congeal in the ports of motors and cause great trouble. These troubles may be reduced to a minimum and even entirely overcome by a thorough system of after-cooling to abstract the moisture. Air cylinders of compressors do not require oil like steam cylinders. What is good for the one is bad for the other. A steam cylinder needs an oil of low flashing point, and plenty of it, because the tendency of the wet steam is to wash the oil out of the cylinder. Not so with air, there is no washing tendency and very little oil will last for a long time. This oil should be of the best quality obtainable and of a high flashing point. It should not be a coking oil; that is, when evaporated upon a piece of hot metal, it should not leave a carbon deposit. This is a subject which has been very much neglected, and this neglect is responsible for much waste of money and, worse than this, for explosions which destroy property and threaten lives. The actual amount of oil that should be used in an air cylinder is one-quarter that which should be used in a steam cylinder of the same size. This is the maximum, for very much less will often suffice, especially where the oil is of the best quality. Too much oil where there is a coking tendency results in choking the valves and ports. A discharge valve might stick through coking, and when stuck it will admit some of the hot compressed air into the cylinder against the receding piston, which on the return stroke is compressed and carried to a temperature beyond the flashing point. Sometimes when discharge valves give trouble, they are cleaned by injecting kerosene. This is a fatal error. Kerosene should never be used in the air cylinder, but, instead of this, fill the oil cup with soap suds, made preferably out of soft soap, and feed this into the cylinder; let the compressor work with soap suds instead of oil for a day each week and no harm is done, care being taken to feed with oil a half hour before stopping, so that the parts may not be subject to rust, which is the only danger from soap suds.

LINING THE SHAFT BEARINGS OF MARINE ENGINES.

Power, June, 1902, p. 27.

It is a matter of prime necessity that the shaft bearings of large marine engines be kept in line, but to make the proper adjustments often calls for considerable ingenuity on the part of the marine engineer. The method employed for lining shafts on the steamships of the American Line, is about as follows:

The two end bearings are chosen, between which the shaft is to be lined, and the original height of its center in each bearing above its datum plane is accurately determined. This height is given by the drawings of the engine, and is usually known and marked on the bearing. Knowing the position the center of the shaft should occupy in the end bearings, a certain height, *h*, vertically above this position is assumed, and directly behind this point is placed a box containing a candle which shines through a very small hole in the box located at the same height as that assumed, as shown at *B* in Fig. 1.

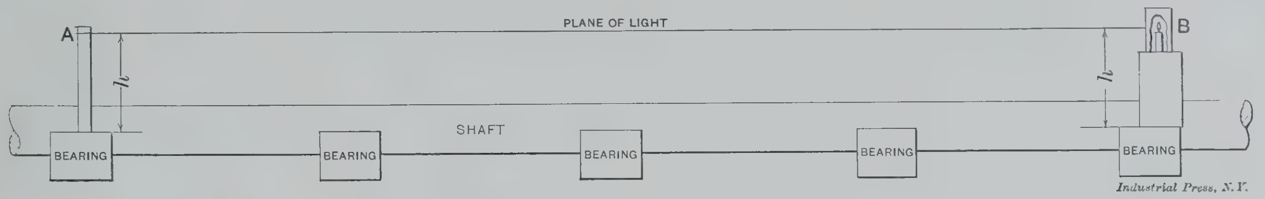


Fig. 1. Lining a Shaft by Means of a Ray of Light.

At the other bearing is placed a wooden framework which forms a very narrow horizontal slit at the same height above the center of the shaft (or where the center ought to be) as the hole in the box at the other bearing, shown at *A*, Fig. 1. The height of the light and slit should be made sufficient so that in looking at the light through the slit, the plane of sight will clear the crank webs or whatever might intervene. The height of the other bearings may now be examined by any convenient method. If the shaft is of uniform diameter, and in line vertically between the two end bearings, the distance below the plane of light, *A B*, of the top of the shaft at any point should be the same as the distance the top of the shaft at the end bearings is below the plane. A handy way to determine these heights is to use a combination of two sticks, as shown in Fig. 2, which also shows the framework forming the slit. The sticks are pivoted as shown, and the horizontal stick is moved by an assistant till it cuts the light as seen through the slit. The point where it cuts the light determines the fixed height above the top of the shaft, and by measuring accurately to the top of the shaft, will show whether the shaft at this point is too high or too low; the amount of its displacement will be h' — (h—radius of shaft). If h' equals, say 40½ inches, h equals 48 inches and the radius of the shaft is 8 inches, we know the shaft is ½ inch low. The height of the shaft, and consequently of the bearings, may be thus determined at each bearing and the results may be plotted in the form of a curve if desired. After the heights at each bearing are determined, the box containing the candle and the framework forming the slit are reversed, each being placed in the position formerly occupied by the other, and the same measurements are again made, from which the average vertical displacement of the shaft can be calculated. If it is not convenient to remove the caps of the bearings so as to determine the height of the shaft in the bearing, the heights can be measured from adjacent points outside the bearings. A small telescope with cross-hairs is sometimes used in place of the slit, but the trouble of finding the light and other points at the same time makes its use too slow for the additional accuracy gained.

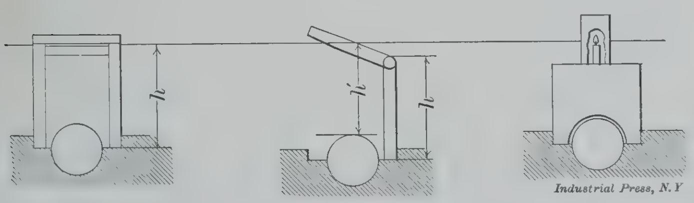


Fig. 2. Showing how to Find Displacement of Shaft.

The lateral displacement of the shaft and bearings can be determined by stretching a wire between the two points directly over the center of the shaft at the end bearings and using a plumb-bob to locate this line on the shaft.

WHY MARINE ENGINE SHAFTS BREAK WITHOUT APPARENT CAUSE.

Jour. of the Am. Soc. Naval Engineers, August, 1902, p. 721.

Marine engineers have for a number of years had to deal with mysterious fractures of shafts taking place during fair weather, and which could not be accounted for by any of the ordinary causes, such as bad material or propellers striking floating bodies.

The peculiar fact that occasionally the lines of fracture of the broken shaft resembled those caused by twisting actions pointed toward the existence of considerable twisting moments, but an explanation as to their origin could not be given. It was out of the question that the steam pressures formed the direct causes of this, as their maximum values, determined by the crank-effort diagram, rarely exceed the average value by more than 50 per cent, and would therefore create a twisting stress of, at most, 300 to 350 kilogrammes per square centimeter, the working stress allowed being about 200 to 230 kilogrammes per square centimeter.

Various authorities had already pointed out that possibly the so-called synchronous vibrations took place in the shafting, but this supposition had not been verified by direct researches. Messrs. Blohm & Voss, of Hamburg, therefore determined, in November, 1899, to study the question experimentally.

The principle of the synchronous vibrations in the shafting is the same as the principle of the vibration of a pendulum. The time required for its complete vibration, back and forth, depends upon the force and frequency of the impulse imparted to it. To be effective, however, these impulses must be in step with the pendulum, occurring regularly at the same point in its vibration. If the impulses are of sufficient force the pendulum will rise higher and higher, while if weak they will extend through a shorter arc.

In the case of the engine shaft there are torsional vibrations set up by the impulses of the steam engine corresponding in effect to the oscillations of a pendulum in a plane. The propeller on the end of the shaft affects the torsional vibration of the shaft in the same way that the weight of a pendulum affects the vibrations of the latter. Once set into vibration, the propeller would oscillate back and forth slightly at regular intervals, the frequency of which depends mainly upon the length and diameter of the shaft. The frequency of the impulses given by the engine, however, depends upon the design of the engine, those with several cranks giving different results from those with only one. An engine crank and connecting rod necessarily produce a varying turning effect on the shaft. With the different combinations possible in marine engine construction instances are not infrequent where the impulses given by the engine are in step with the natural vibrations of the shaft and may be of sufficient force to increase the extent of the vibrations to the danger point, just as the impulses upon the pendulum increase the height of its vibration.

To illustrate this point the author cites the case of a shaft in which, according to calculation, the individual number of vibrations per minute were 257.4. On a trial trip with the vessel it was possible to run at such a speed that the impulses were synchronous with these vibrations and by means of the recording instruments used it was demonstrated that the shaft became strained by a moment almost equal to three times the average turning moment, and that between these times it sprung back past the neutral line into the negative region of strain. At certain points the kinetic energy of the propeller actually drew the engine along and the shaft was strained intermittently to an extent which considerably exceeded the safe limit.

The experiments made on this subject were very elaborate and the treatment of it is highly mathematical. Directions are given for working through the problem in designing a marine equipment, and when it is found that a synchronous action is likely to occur the diameter of the shaft should be changed to make the vibrations of the shaft out of step with the periodic variations in the turning moment of the engine.

HORSE POWER OF MARINE ENGINES MEASURED BY SHAFT TORSION.

Journal of the American Society of Naval Engineers, August, 1902, p. 721.

In the tests upon the torsional vibrations of shafting, mentioned in the foregoing extract, it became necessary to measure the transmitted forces between engine and propeller. This was accomplished by accurately determining the amounts of twist of the shaft, and it is believed to be the first instance where the net or brake horse power of engines of several thousand horse power has been found. As stated below the horse power was probably estimated by this method within very close limits.

In order to calculate the transmitted forces accurately by means of the measured amounts of twist one must know the modulus of elasticity for shearing of the shafting.

As no suitable data were available from the technical literature, Messrs. Blohm & Voss determined not to start on possibly erroneous assumptions but had the modulus found by special experiment.

For this purpose three experimental shafts of 2,500 millimeters length by 60 millimeters diameter were ordered in the spring of 1900, from each of the following firms: Friedr. Krupp, Essen; Bochumer Verein, Bochum; Gewerkschaft Witkowitz, Witkowitz in Mähren, stipulating that they were to be made from the same material and treated in the same way as marine shafting proper.

These experimental shafts were subjected to exhaustive torsion tests, which showed that the modulus of the material experimented upon—Siemens-Martin steel of 40 to 47 kilogrammes breaking strength per square millimeter (57,000 to 67,000 pounds per square inch) and over 20 per cent elongation—varies by remarkably small amounts, and very nearly agrees with the average value, 828,000 kilogrammes per square centimeter (11,776,600 pounds per square inch).

This figure was then made use of to determine the effective power transmitted, and thus the ratio which it bore to the indicated horse power—i. e., the mechanical efficiency of those engines—could be found.

As far as I know, the so-called brake horse power of engines developing several thousand horse power has never been measured accurately before this. The method which, practically speaking, makes use of the shafting as a torsional spring can, of course, only be applied to marine engines having these long shafts, or to installations with long-shaft transmissions.

The efficiency in the cases examined varied between 92 and 88 per cent. Lower values, down to 82 per cent, were only found in special cases. The accuracy which may be attained in these experiments is estimated at 0.5 to 1.0 per cent. This also is about the degree of accuracy which one may, at most, expect when calculating the indicated horse power from indicator cards.

THE STEAMSHIP KROONLAND.

Marine Engineering, September, 1902, p. 429.

The largest steamship built in America to date is the Kroonland, for the Red Star Line of the International Navigation Co. The new vessel was launched last February, and only four months elapsed from the launching until the first voyage. Such remarkably rapid work has been made possible by the general improvements that have been made in shipyard tools and appliances within the past few years. Practically all the rivets in the hull and superstructure of this vessel were driven by power. While machine riveting has been generally employed in all shipyards for some years, it has always been necessary to drive a large proportion of the rivets by hand on account of the practical impossibility of adapting hydraulic riveting machinery to the many intricate parts of a ship where riveting must be done. The use of pneumatic riveters, however, has worked a great improvement in machine riveting, so that it is now possible to do practically all the riveting of a ship with these tools.

The Kroonland is 560 feet long between perpendiculars, 60 feet wide and 42 feet deep. When loaded to her full draft of 31 feet she has a displacement of 22,100 tons. Being a twin-screw ship, there are two sets of engines which are triple expansion and have an aggregate of 10,200 I. H. P. The cylinder diameters are 32½, 54 and 89½ inches with a common stroke of 54 inches. The total condensing surface is 14,000 square feet, or nearly 1.4 square feet per one I. H. P. Steam is supplied by nine single-ended Scotch boilers, each having a diameter of 15 feet 10 inches and a length of 10 feet 5½ inches. Each boiler has four Fox furnaces, and the total grate surface for the nine boilers is 643.5 square feet. The total heating surface is 22,400 square feet, making the ratio of I. H. P. to heating surface 1 to 2.2. The boiler pressure is 170 pounds.

The engines are fitted with piston valves, and the valve gear is of the double eccentric link type generally used on marine engines. The crankshafts are 16¾ inches in diameter and are made interchangeable, so that a spare crankshaft may be used for either engine in case of accident. The lineshafts connecting the crankshafts and tailshafts are 15¾ inches in diameter. They are fitted with Verity flexible couplings, two in each, to compensate for any irregularity of alignment. The tailshafts are 18¼ inches in diameter, and are protected by brass liners 1 inch thick. A feature of the engine construction is that the piston rods of the intermediate and low-pressure cylinders are flanged and secured to the pistons by six bolts instead of the usual taper fit and large nut.

HOW A LARGE PULLEY WAS TURNED TO A SMALLER DIAMETER.

Practical Engineer, August, 1902, p. 12.

A few years ago the American Cement Co. erected a plant at Jarden, Pa., in which power was transmitted from a 24 x 48-inch Corliss engine to two line shafts by means of two double 36-inch belts. One line shaft was in front of the engine and the other back of it and the belts leading up to the pulleys were both carried on the same flywheel. The pulley on one line shaft was 37½ inches face and 15 feet in diameter and the other was of the same width of face, but 15 feet ⅜ inch diameter. The slight difference in diameter made no particular difference under the circumstances.

After being installed for about twelve years, the plant was dismantled and the machinery removed to a factory at Egypt, Pa., including the old engine and line shaft pulleys. In the new factory it was proposed to belt the engine to one line-shaft and mount the two pulleys side by side, but this was about to be abandoned when the difference in diameter was discovered. A practical mechanic, however, suggested that the larger pulley could be turned down at the factory without great expense, which was done.

Both pulleys were mounted on a shaft and securely fastened to it. The shaft was provided with suitable bearings so the pulleys were free to turn. In front of them a cylinder boring bar was rigged on 10 x 10-inch timbers arranged in crib form. The bar was held in two hard wood boxes and was set square with the pulley faces. An eccentric was rigged on the shaft to give the necessary feed motion. The pulleys were driven by a belt incircling one and leading to a jack shaft fastened to the floor about twenty feet in front of the boring bar. A five horse power engine drove the jack shaft through triple reducing gears, and the 36-inch pulley on the jackshaft transmitted motion to the pulleys at about 42 feet per minute.

The larger pulley was turned off first and then a cut was taken over the faces of both, a distance of 6 feet 3 inches. Then surface was crowned, leaving a space 18 inches in the center flat. The cost of the job was only a little in excess of the freight and cartage on a new one.

ROLLING MILL ENGINE OF 6000 H. P.

Engineering News, August 28, 1902, p. 138.

The Filer & Stowell Co., Milwaukee, Wis., have recently built for the Republic Iron & Steel Co., Youngstown, O., a rolling mill engine of the Corliss cross-compound type which is rated at 6,000 H. P. when running at 65 turns per minute with a steam pressure of 140 pounds. The high-pressure cylinder is 44 x 60 inches and the low-pressure 82 x 60 inches. The frame with main bearing and guides, is formed in one great casting 26 feet 2 inches long and weighing about 45 tons. No legs or pedestals are used, the entire frame forming a flat bed-plate with a continuous bearing on the masonry foundation. The piston rods are of forged steel 9 and 11 inches in diameter. The piston rods are threaded to screw into the crossheads and the usual jam nuts are provided for locking. In addition the crossheads are split where they embrace the rods and clamping bolts are provided to tightly clamp the threaded parts of the rods. The crossheads are of cast steel with independent steel shoes top and bottom, the shoes being turned to radius of 38 inches to fit the bored guides. The shoes are faced with 7-16 inch babbitt metal. In order to prevent the great weight of the pistons wearing and scoring the cylinders, the piston rods are extended so as to form tail rods which are provided with outer bearings to carry the weight. The pistons and piston rods are thus supported on the crossheads and tail rod slippers. The high-pressure piston is of cast steel with double walls; the low-pressure piston is also of cast steel, but of single thickness. The connecting rods are 14 feet center to center. The crosshead pin of the low-pressure cylinder is 12 inches in diameter, and the crank 23 inches. The high pressure crank is 14 inches diameter. The crankshaft is made of double refined hammered iron, and is 20 feet 6 inches long, 23 inches diameter at the low-pressure crank, 26 inches diameter at the wheel fit and has two bearings 25 x 43½ inches. There are two keyways in each crank and two in the wheel hub. The flywheel is 24 feet in diameter, 19 inches wide on the face and weighs 150,000 pounds. It is of the "built-up" form and consists of ten segments each carrying a spoke. The segments of the rim are held together by steel links of the "dumb-bell" pattern shrunk into recesses in the sides. The valves are of the Corliss pattern and are operated by two eccentrics on each cylinder. The eccentrics are 44 inches diameter and 7 inches face. The throw is 10⅛ inches for the steam and 11½ inches for the exhaust on the high-pressure side and 13⅛ inches and 13¼ inches on the low-pressure side. The engine is for rolling structural shapes.

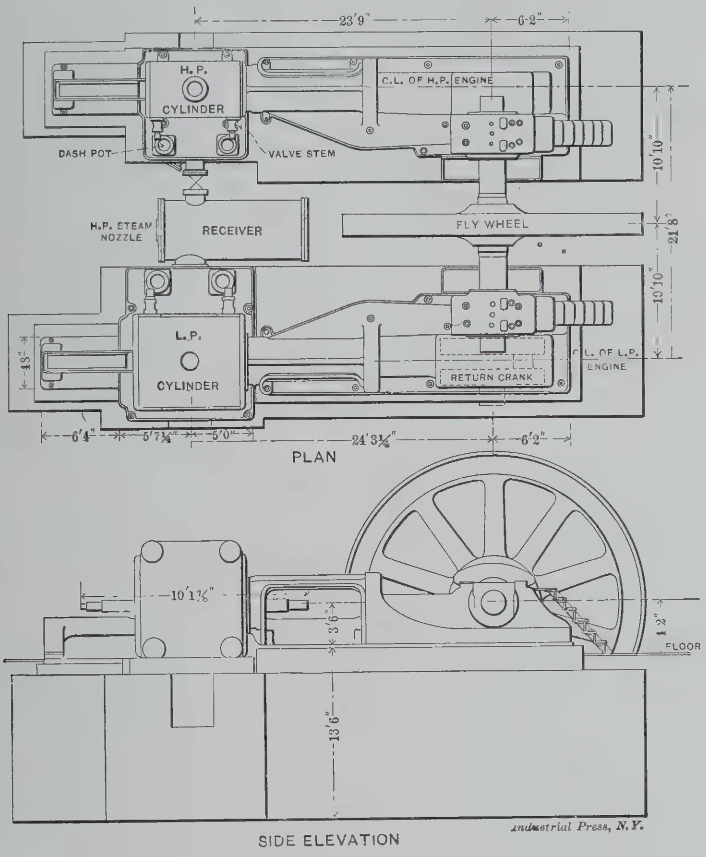


Fig. 3. Plan and Elevation of 6000 H. P. Engine.

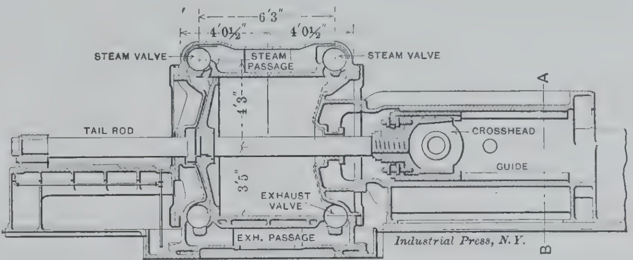


Fig. 4. Section of Cylinder, Piston and Crosshead.

IMPROVED BOILER JOINT.

Railway and Locomotive Engineering, August, 1902, p. 336.

Mr. Samuel M. Vauclain, superintendent of the Baldwin Locomotive Works, Philadelphia, has recently designed and patented a horizontal boiler seam, which is claimed to have 96 per cent. of the strength of the solid plate. This is a very substantial increase in strength, when it is remembered that the ordinary sextuple-riveted, double-welt, butt joint has about 85 per cent. of the strength of an unperforated boiler plate. Mr. Vauclain's seam is a butt joint, with double welt, the under one being diamond-shaped. In the seam shown in our illustration there is one rivet, at the corner of the under welt, 22⅞ inches from the butt-joint. The tensile strength of the plate at this point is that of the entire sheet, minus one rivet-hole 1¾ inches in diameter. At a distance of 4½ inches nearer the seam, the plate has its full tensile strength, minus two such holes, widely spaced, plus the shearing strength of the rivet at the apex of the triangle made by half the diamond welt. On the third row, it will be seen, the strength of the plate has been reduced by three widely-spaced holes, but it is assisted by three good rivets in single shear. On the fourth row, the plate, weakened by four holes, is reinforced by the shearing strength of six rivets. On the next line, just outside the upper welt, there are nine holes, but beyond them are ten rivets in shear. When we come to the double welt itself, there are 17 holes in it, with 19 rivets in the half diamond of the lower welt. All the rivets in the row along this welt are in double shear. This means that they pass through three plates, thus giving two planes where shearing forces act. Rivets in double shear are very nearly, though not quite, equal to twice the value of rivets in single shear, or those which pass through only two plates.

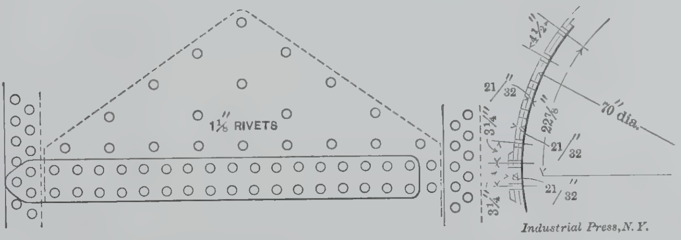


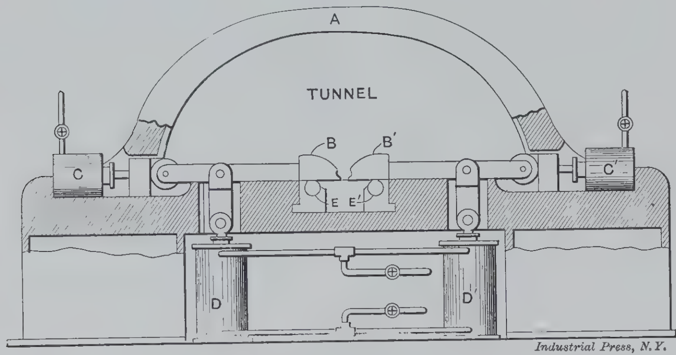
Fig. 5. Boiler Joint having 96 per cent. Efficiency.

Adding together all the advantages and subtracting the disadvantages, if one may say so, or more correctly, taking the algebraic sum of all the additions to strength, and all the reductions of strength in this arrangement of plates and rivets, it has been found by test that this seam is about 96 per cent. as strong as the original plate itself. The diamond-shaped welt here used, secures this advantage, that on each line of rivets, the holes are comparatively few and far between, and as the seam itself is approached, the total number of rivets outside each succeeding line, almost makes up for the loss due to the holes punched.

A NEW PROCESS OF MAKING CUTLERY.

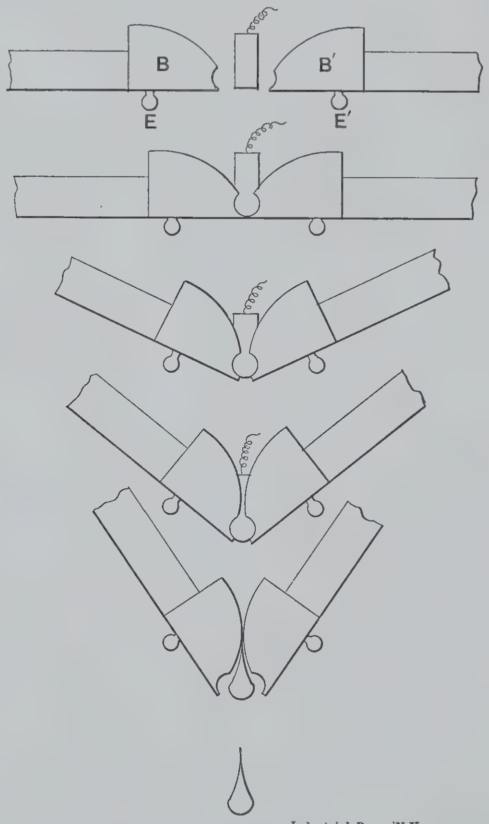
Electrical Age, September, 1902, p. 388.

The methods followed to-day in the manufacture of cutlery do not differ essentially from those followed a hundred years ago, and so far as we know, they may have originated with Tubal Cain, who is alleged to have been the first worker in iron. The making of a knife blade, for instance, requires that it first be forged to the approximate shape required; it is then ground, hardened and tempered, reground and polished. In the manufacture of knife blades in large quantities these operations may be subdivided so that each blade may pass through a score or more of hands before it is ready for the market—and the chances are about even that it will be an indifferent tool when completed owing to uncertainty of hardening and tempering.



Industrial Press, N.Y.

Fig. 6. Diagram of Forging Machine for Misko System of Forging.



Industrial Press, N.Y.

Fig. 7. The Successive Steps in the Misko Process.

Should, however, the process invented by Joseph Misko, Pittsburg, Pa., prove as successful as it is represented to be, it will very likely revolutionize the art. As might be expected, the modern wonder-worker—electricity—plays the principal rôle in the new process. The steel for blades is heated both for hardening and tempering by a powerful electric current while in a vacuum and the forging is also done under the same conditions, the air being excluded to prevent oxidization. Since the blade is not exposed to the air it may be ground before being forged to remove the scale and then shaped to the exact shape required and to a sharp edge without fear of injury.

So in the Misko system the usual process of manufacture is reversed. The grinding and polishing are done before the forging is begun. A rod of steel, say, ten feet long or of any other convenient length, is taken for the initial process. The rod is ground on all sides and polished. In this state it contains just enough material for the forming of the blades into which it is to be converted. It is now ready for the forging.

The forging machine is a tunnel of steel a little longer than the steel rod. Lying along the middle of this tunnel and with their ends separated enough to receive the prepared rod and yet not touch it, is a double row of dies *B B′* reaching almost to the full length of the rod.

Each pair of these dies is ready to form a blade, each die forming one side of it. The upper part of the tunnel *A* is an arch of steel which trusses the dies together and serves also as a guide to them in their forging operation. At each end of the dies are hydraulic presses *C C′* and there are more of these below the dies on either side, as at *D D′*.

The operator thrusts the rod of cold polished steel into the tunnel and between the die heads. He closes the door and touches a button. Powerful pumps quickly exhaust the air out of the machine. As the door closes and seals itself, electrical connections are made on either end of the polished steel rod. As the air disappears from the inside of the chamber the electric current is turned on. In a few seconds the rod is at a cherry-red forging heat. Another touch by the operator and the dies close together, forming with their ends the backs of the blades into which the rod is to be transformed. Another touch and the far ends of the dies begin to travel up the arched sides of the tunnel. As they move the inner ends close more and more with a revolving motion, squeezing down the steel between them until at the last it is forced into a sharp edge.

The operator returns the dies to their places, cuts off the current and opens the machine. The steel rod has been transformed into a series of shining polished blades. There are nicks between the blades, marking where they are to be broken apart later. As there was no air in the forging chamber the blades have lost none of the brightness of the polished rod of steel.

The next operation is the hardening. Again the rod of blades is placed in a tunnel and the air is exhausted. This time instead of dies there are, on either side of the rod, heads of metal indented to fit the blades and inside each head runs a stream of refrigerating brine, cooled to below the zero of the thermometer. The current is again applied to heat the rod of blades and when they are glowing the refrigerated heads close together, chilling the thin steel, but doing it so evenly, that it is claimed there is no tendency to produce warping or cracking.

Still the blades are bright and polished when they come from the hardening machine. To put the finishing touch to the blades, Mr. Misko has devised a refrigerated grinding and polishing wheel on which the cutlery would be kept from losing its temper though it were ground dry as is the custom. These wheels are of hollow iron with the abrasive substances cemented to their outer edges and the whole kept cool by a stream of freezing brine run through the inside of the wheel. A factory to make use of this process will soon be erected at Newcastle, Pa.

AN EXAMPLE OF THE EXTENSIVE USE OF STEEL CASTINGS IN LOCOMOTIVE CONSTRUCTION.

Railway Age, August 29, 1902, p. 202.

A noticeable feature of modern locomotives is the graceful outlines of the component parts. Sharp angles have given way to curves and fillets with a resulting improvement in the strength and durability of the parts as well as appearance. The evolution in this direction has been gradual and improved shop machinery has been responsible to some extent for the change. The introduction of heavy milling machines has made it possible to finish parts of curved contour as economically as straight surfaces can be finished on the planer. More-

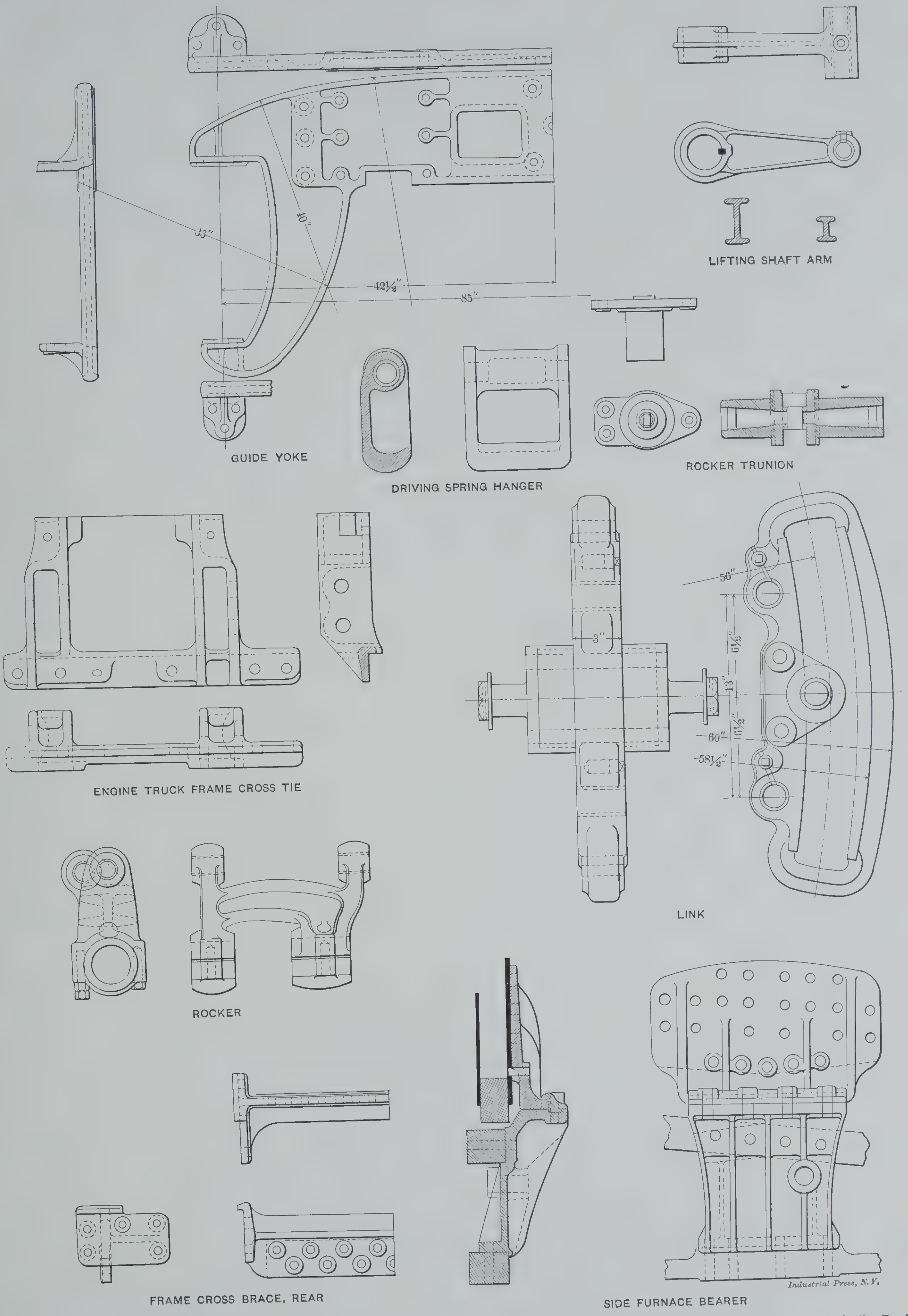


Fig. 8. Example of Steel Castings used in Modern Locomotive Construction and Illustrating the Wonderful Advances that have been made in the Production and Use of Steel Castings.

over, the development in the manufacture of steel castings has made it possible to substitute this metal for parts that heretofore have been made of wrought iron and cast iron and employ designs that embody greater strength with less weight. This change of design is more apparent in cast steel parts that have been substituted for wrought iron. An illustration of the substitution that may be carried out is found in the construction of some new locomotives recently built by the Brooks Works of the American Locomotive Company for the National Railroad of Mexico.

The illustrations show locomotive parts that have been made of cast steel only in recent years. Special mention may be made of the use of cast steel for reverse shaft lifters, the horizontal arm only is shown, but the vertical arm is also of the same material. The guide yoke evidently costs much less for machine work than when made of wrought iron and is of stronger and better design for the same weight of material. The guide blocks are cast integral with the yoke which is an example of the machining and fitting saved by the use of steel castings. The links are also steel castings. They are supported by double hangers and the saddles are both fastened to the inner arc. Case-hardened steel bushings are provided for the eccentric pins and the inner faces of the links are case-hardened in the usual manner. Oil cups are cast integral with the links and are made solid. The cavity for oil is made by drilling a ⅝-inch hole transversely to a suitable depth. This opening is tapped and closed with a ½-inch pipe plug. A ¼-inch hole is drilled from the top through the oil receptacle and into the eccentric pin hole to supply oil to the bearings. The oil cups are filled with curled hair to absorb the oil and act as a filter to prevent the entrance of dust and cinders to the bearings of the pins. The details of the other cast steel parts may be observed by inspection of the cuts.

NOTES ON TUBULAR BOILERS.

American Electrician, September, 1902, p. 438.

The Centennial standard boiler horse power is the evaporation of 30 pounds of water from a temperature of 100 degrees into steam at 70 pounds pressure, or the evaporation of 34½ pounds of water from and at a temperature of 212 degrees F. These are practically equal, since the first requires the absorption of about 33,308 British thermal units (B. T. U.) and the second, about 33,316 B. T. U. In plain tubular boilers it has been found that on an average one foot of heating surface will evaporate 2.3 pounds of water into steam when at an initial temperature of 212 degrees. This corresponds to 15 square feet of heating surface per boiler horse power, which is a conservative figure, since many authorities make it as low as 11½ square feet per boiler horse power. The amount of coal burned per square foot of grate surface

DIMENSIONS FOR TUBULAR BOILERS.

Diameter of Boiler.	Number of Tubes.	Diameter of Tubes.	Area through Tubes in sq. ft.	Sq. ft. H. S. in Heads.	Sq. ft. H. S. in 1 lin ft. Shell and Tubes.	H. P. in 1 lineal foot Shell and Tubes.	Length of Tubes.	Horse-power.	Rate of Evaporation, nine pounds Steam per pound of Coal.				Rate of Evaporation, eight pounds Steam per pound of Coal.			
									Size of Grate.	Size of Uptake.	Area Smoke-pipe, sq. in.	Coal per sq. ft. Grate per hr.	Size of Grate.	Size of Uptake.	Area Smoke-pipe, sq. in.	Coal per sq. ft. Grate per hr.
30	28	2½	.78	2.8	20.7	1.37	6	8.5					24 x 36	10 x 14	140	6
							7	9.9					24 x 36	10 x 14	140	7
							8	11.2					24 x 36	10 x 14	140	8
							9	12.6					24 x 42	10 x 14	140	8
							10	14.0					24 x 42	10 x 14	140	8½
36	34	2½	.97	4.0	25.0	1.67	8	13.6					30 x 36	10 x 16	160	8½
							9	15.3					30 x 42	10 x 18	180	8½
							10	16.9					30 x 42	10 x 18	180	9
							11	18.6					30 x 48	10 x 20	200	9
							12	20.9					30 x 48	10 x 20	200	9½
42	34	3	1.44	5.3	30.2	2.0	9	18.5	36 x 36	10 x 20	180	9	36 x 42	10 x 20	200	8½
							10	20.5	36 x 36	10 x 20	180	9½	36 x 42	10 x 20	200	9
							11	22.5	36 x 36	10 x 20	180	10½	36 x 48	10 x 25	250	9
							12	24 5	36 x 36	10 x 20	180	11½	36 x 48	10 x 25	250	9½
							13	26.5	36 x 42	10 x 22	200	11	36 x 48	10 x 25	250	10½
							14	28.5	36 x 42	10 x 22	200	12	36 x 54	10 x 28	280	10½
48	44	3	1.86	7.2	38.4	2.56	10	30.4	42 x 36	10 x 22	200	11	42 x 48	10 x 28	280	9
							11	33.2	42 x 36	10 x 22	200	12	42 x 48	10 x 28	280	10
							12	35.7	42 x 42	10 x 25	220	11½	42 x 54	10 x 32	320	10
							13	38.3	42 x 42	10 x 25	220	12	42 x 54	10 x 32	320	10½
							14	40 8	42 x 42	10 x 25	220	12½	42 x 60	10 x 36	360	10½
							15	43.4	42 x 48	10 x 28	250	12	42 x 60	10 x 36	360	11
							16	45.9	42 x 48	10 x 28	250	12½	42 x 60	10 x 36	360	11
54	54	3	2.28	9.3	46.4	3.10	11	34.6	48 x 42	10 x 28	250	9½	48 x 54	10 x 38	380	8½
							12	37.7	48 x 42	10 x 28	250	10	48 x 54	10 x 38	380	9
							13	40.8	48 x 42	10 x 28	250	11	48 x 54	10 x 38	380	10
							14	43.9	48 x 42	10 x 28	250	12	48 x 54	10 x 38	380	10½
							15	47.0	48 x 48	10 x 33	290	11½	48 x 60	10 x 40	400	10
							16	50.1	48 x 54	10 x 38	320	12	48 x 60	10 x 40	400	11
	46	3½	2.67	8.8	46.3	3.10	17	53.0	48 x 54	10 x 38	320	12½	48 x 60	10 x 40	400	11½
60	72	3	3.04	11.2	59.6	4.0	12	48.4	54 x 48	10 x 38	320	10	54 x 60	12 x 40	460	9½
							13	52.4	54 x 48	10 x 38	320	10½	54 x 60	12 x 40	460	10
							14	56.4	54 x 48	10 x 38	320	12	54 x 60	12 x 40	460	11
							15	60.4	54 x 54	12 x 35	370	12	54 x 66	12 x 42	500	10½
							16	64 4	54 x 54	12 x 35	370	12½	54 x 66	12 x 42	500	11½
	64	3½	3.71	10.5	62.4	4.16	17	71.4	54 x 60	12 x 40	400	12½	54 x 72	12 x 48	550	11½
							18	75.6	54 x 60	12 x 40	400	13½	54 x 72	12 x 48	550	12
66	90	3	3.80	13.5	74 2	4.95	14	70.1	60 x 54	12 x 40	400	12	60 x 66	12 x 48	500	11
							15	75.0	60 x 60	12 x 44	450	12	60 x 72	12 x 52	620	11
							16	80.0	60 x 60	12 x 44	450	12½	60 x 72	12 x 52	620	12
	78	3½	4.52	12.6	75.2	5.10	17	86.0	60 x 60	12 x 44	450	13	66 x 72	12 x 56	670	11½
							18	91 1	60 x 60	12 x 44	450	13½	66 x 72	12 x 56	670	12
							19	96.2	60 x 66	12 x 48	500	13	66 x 72	12 x 56	670	12½
	62	4	4.32	12.4	69.2	4.60	20	93.1	60 x 66	12 x 48	500	13	66 x 72	12 x 56	670	12
72	114	3	4.81	15.7	92.5	6.16	14	87.4	66 x 60	12 x 48	500	12	66 x 72	12 x 56	670	11½
							15	93.6	66 x 60	12 x 48	500	13	66 x 72	12 x 56	670	12
							16	99.7	66 x 60	12 x 48	500	14	72 x 72	12 x 62	740	12
	98	3½	5.75	15.0	93.0	6.20	17	106.4	66 x 66	12 x 52	540	13½	72 x 72	12 x 62	740	13
							18	112.6	66 x 66	12 x 52	540	14	72 x 78	12 x 66	790	12½
							19	118.8	66 x 66	12 x 52	540	14½	72 x 78	12 x 66	790	13
	72	4	5.02	15.0	79.7	5.31	20	107.3	66 x 60	12 x 48	500	14½	72 x 72	12 x 62	740	13

varies with the chimney draft, the kind of coal and the care given to firing, but it will be rarely less than 15 pounds per square foot grate area per hour. The rate of evaporation may vary from 8 to 10½ pounds of water per pound of coal. Professor Carpenter gives the average for power boilers as 9 pounds when the tubes are clean and the boiler in good general condition. In smaller boilers the rate of evaporation is less, the figures given ranging from 5.7 for a 5-horse power boiler to 8 pounds for a 30-horse power boiler. The grate surface required per horse power is determined by the formula:

$$\text{Grate surface} = \frac{34.5 \times \text{H. P.}}{A \times B} \text{ in which}$$

H. P. is the horse power required; A, the rate of evaporation; and B, the rate of combustion. Assuming the rate of evaporation to be 9 pounds per pound of coal and the rate of combustion to be 15 pounds per square foot of grate area, it will be found that for a 100 horse power boiler a grate surface of 25.5 square feet will be required. The cross section area of the uptake should be about 1-7 the grate area, and of the smoke pipe, from 1-7 to 1-10. The general rule for the sizes of tubes in horizontal stationary tubular boilers, is to allow one inch of diameter for four feet of length where soft coal is used, and one inch of diameter for five feet of length where hard coal is the fuel.

Table 1 gives the horse power and other data for different sizes of boiler. The number of tubes specified corresponds closely with that recommended by the leading insurance companies, but may be increased somewhat in special cases, if necessary, to secure a required heating surface within a given space. In such a case it is better, if possible, to select a larger shell and use the number of tubes specified in the table for that diameter. Two sizes of grate and smoke pipe are given for each boiler, one being computed for an evaporation of 9 pounds of water per pound of coal, and the other for an evaporation of 8 pounds, which figures correspond to average practice in power and heating service, respectively. The width of the grate is usually made 6 inches less than the diameter of the shell, while the length may be varied within certain limits to give the required grate surface. The length of the grate, however, should not exceed 6 feet in hand-fired furnaces. Grates 4 feet long and over should be made in two sections, so as to use short grate bars, which are less likely to warp than longer ones.

In the second table, below, are given the working pressures of boilers having different diameters and thicknesses of shell and different types of joints.

GIVING THEORETICAL WORKING PRESSURES FOR BOILERS OF DIFFERENT DIAMETER, THICKNESS OF SHELL, FACTOR OF SAFETY AND TYPE OF JOINT.

Assumed strength of plates, 55,000 pounds.

The assumed efficiency of joints, single lap 54 per cent., double lap 70 per cent., double butt 80 per cent., triple butt 88 per cent.

Diameter of Boiler.	Thickness of Shell.	FACTOR OF SAFETY 6.				FACTOR OF SAFETY 5.				FACTOR OF SAFETY 4.			
		KIND OF JOINT.				KIND OF JOINT.				KIND OF JOINT.			
		Single Lap.	Douole Lap.	Double Butt.	Triple Butt.	Single Lap.	Double Lap.	Double Butt.	Triple Butt.	Single Lap.	Double Lap.	Double Butt.	Triple Butt.
30″	1/4	82	107	123	137	98	128	147	163	123	160	184	204
	5/16	103	134	155	172	124	161	186	205	155	201	232	257
	3/8	124	161	186	205	148	192	221	245	185	240	277	307
	7/16	145	188	217	240	173	225	259	286	216	281	324	358
	1/2	165	215	248	275	198	257	296	328	247	321	370	410
36″	1/4	69	90	103	115	82	107	123	137	103	134	154	171
	5/16	86	112	129	143	103	134	154	171	129	168	193	214
	3/8	103	134	155	171	123	160	185	204	154	200	231	255
	7/16	120	157	181	201	144	187	216	239	180	234	270	299
	1/2	138	180	207	229	165	214	247	274	206	268	309	342
42″	1/4	59	76	88	98	70	91	105	117	88	114	132	146
	5/16	73	96	110	122	88	115	132	145	110	143	165	182
	3/8	88	115	133	147	105	137	158	175	132	171	198	219
	7/16	103	134	155	170	123	160	185	204	154	200	231	255
	1/2	118	154	178	197	142	184	212	235	177	230	265	294
48″	1/4	52	67	77	86	62	80	92	102	77	100	115	128
	5/16	64	84	96	106	77	100	115	127	96	125	144	159
	3/8	78	100	116	129	93	120	139	154	116	150	174	193
	7/16	90	118	135	150	108	140	162	179	135	176	203	224
	1/2	104	135	155	172	124	162	185	205	155	202	232	257
54″	1/4	46	59	68	76	54	70	82	90	68	88	102	113
	5/16	58	75	86	96	69	90	103	114	86	112	129	143
	3/8	69	90	103	115	82	107	123	137	103	134	154	171
	7/16	80	105	120	134	96	125	144	159	120	156	180	199
	1/2	92	119	137	152	109	142	163	182	137	178	205	227
60″	1/4	41	53	62	68	49	64	73	82	62	80	92	102
	5/16	51	67	77	86	62	81	93	102	77	100	116	128
	3/8	62	81	93	102	74	96	110	122	93	120	138	153
	7/16	72	94	109	120	87	112	129	143	108	140	162	179
	1/2	82	108	124	137	99	128	148	164	124	160	185	205
66″	1/4	38	49	56	62	45	58	67	74	56	73	84	93
	5/16	47	61	70	78	56	73	84	93	70	91	105	116
	3/8	56	73	84	92	67	87	100	113	84	109	126	139
	7/16	66	85	98	109	78	102	118	130	98	127	147	163
	1/2	75	98	113	125	90	117	134	149	112	146	168	186
72″	1/4	35	45	51	57	41	54	61	68	52	67	77	85
	5/16	43	56	65	71	51	67	77	85	65	84	96	107
	3/8	51	67	77	85	61	80	92	102	77	100	116	127
	7/16	60	78	91	101	72	94	108	119	90	117	135	145
	1/2	69	90	104	114	82	107	123	137	103	134	155	171

BURNING BRASS TIPS ON CAST IRON PROPELLERS.

The Foundry, September, 1902, p. 22.

A method of repairing cast iron propeller wheels is in vogue at Mort's Dock & Engineering Co.'s foundry, Sydney, N. S. W., which is said to be practically unknown in Europe and America. It is the fusion of gun-metal tips to cast iron propeller blades by the "burning-on" process. On account of cost, cast iron propellers are used to a large extent although they are, of course, much inferior to bronze in point of durability. The "tips," the portion 12 to 18 inches from the ends of the blades, are likely to be broken by striking floating debris, hidden rocks, wharf projections, "racing," etc., but the greatest source of damage in the case of steel and iron vessels, is corrosion due to galvanic action.

When a propeller blade is broken, the usual method of repair is to replace it with a new one, but it sometimes happens that a ship cannot be detained in port long enough to allow a new blade to be made and in that case a new tip is "burned on," which can be done in a few hours. The blade to be repaired is taken to a drilling machine and drilled across with holes about one-half inch apart, so that the bad part may be easily broken off. It is then taken into the iron foundry, bedded in the floor, and a cope rammed up over the portion that is to be renewed. The mold is then parted, finished, dried, closed and cast with gun metal in place of the cast iron tip which has been broken off. The gun metal having been cast against the cast iron blade, it has now to be "burned" to it.

The cope is thrown off while the casting is hot, and an "open" burn laid right across where the brass and iron join. It is then burned with iron, care being taken that the metal from the ladle falls directly onto the iron part of the blade so as to cut into it without washing away too much of the brass. If attention is given to the center, or thickest part of the blade in the process of burning, one can always make sure of a satisfactory joint. The proper way is to use a feeding rod as a guide, working it along the joint gradually as the iron dissolves. After the burn is thoroughly cooled, it is trimmed off and the blade sent to the ship. Although a blade treated in this way presents a somewhat piebald appearance—owing to the light and shade of brass and iron—there is nothing weak about it. All sorts of mechanical tests have been made in order to separate the brass and iron, without success. The bronze tip is not, of course, affected by corrosion, so the repaired blade is practically better than the original.

HEADLIGHT WITH HORIZONTAL AND VERTICAL BEAMS.

Scientific American, September 13, 1902, p. 170.

A new type of headlight which has recently been put in service by the Chicago, Milwaukee and St. Paul Railway, promises to have a very extended application among the railroads of this country. It is an electric headlight which, in addition to sending a powerful ray along the tracks in front of the engine, also projects a powerful vertical beam. The vertical beam makes a very decided illumination in the heavens, so much so that it is possible not only to detect the presence of an engine, but also in many cases to follow its path and determine in which way it is heading. An engineer is by this means placed in touch with the movements of other trains in his vicinity, and is enabled to detect their presence where, if they carried ordinary horizontal beam headlights, he would be unaware of their location.

With the vertical beam, of course, an approaching locomotive can be located when it is hidden from direct view by a curve or an intervening hill.

The headlight equipment, which is built by the Edwards Railroad Electric Light Company, consists of four parts: first, the motor, a simple-acting steam turbine; secondly, the dynamo, mounted on the same axle with the turbine and designed to yield to the arc light a current of from 30 to 33 amperes and from 30 to 33 volts; thirdly, the lamp, including the arc, the deflectors and the case; and fourthly, the bed-plate on which the whole apparatus is mounted.

The steam turbine is provided with a propeller wheel which is wholly constructed of rolled steel. It has a factor of safety of about 7, for while the normal speed of the engine and dynamo is about 2,000 R. P. M., the wheel will withstand successfully a speed of about 14,000 R. P. M. The speed of the engine is held constant, or practically so, regardless of change of load or initial pressure, by a simple and efficient governor, which is so arranged with relation to the other parts of the engine as to be easily and readily accessible, should occasion demand. The wheel shaft is journaled in ball bearings, giving a low coefficient of friction.

The novel feature of the equipment is the provision of an auxiliary plane deflector, placed outside the goggle at an angle of 45 degrees and in such a position as to intercept about 40 per cent. of the whole volume of light issuing from the parabolic reflector and direct it vertically. This vertical beam forms a constant warning signal. Reaching to a great height, and on cloudy nights striking the clouds, it can be seen for many miles. In fact, upon the Big Four road it has been seen for a distance of 21 miles, and on the Chicago, Milwaukee and St. Paul road it has been seen for a distance exceeding 16 miles. The horizontal beam is very powerful, showing up clearly three-quarters of a mile to a mile, on a clear, straight track, ahead of the locomotive bearing it.

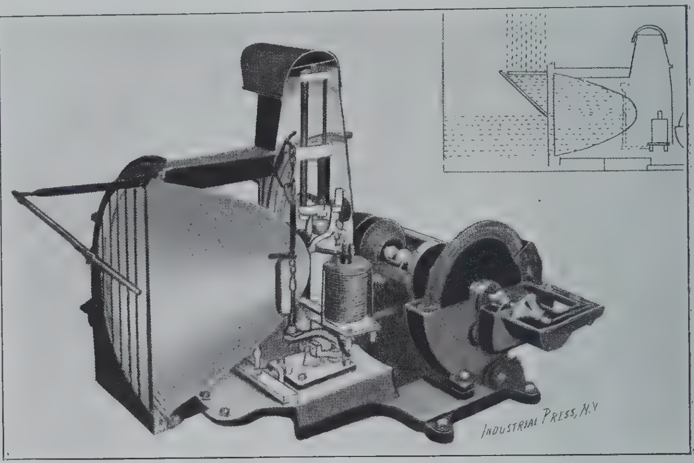


Fig. 9. Showing Arrangement of Headlight.

DOUBLE PLANER TOOL FOR MACHINING DRIVING BOXES.

Railway and Engineering Review, August 9, 1902, p. 505.

A device to be used in connection with a circular planer tool for facilitating the work of machining driving box crown-brass and cellar fits has been designed at the Marshall, Texas, shops of the Texas & Pacific Railway. For a number of years it has been the practice at the above-mentioned shop to slot brass and cellar fits, but some time ago a Pedrick & Ayer circular planer was installed and that class of work accomplished thereon. The arrangement resulted very satisfactorily as regards the quality of the work and reduction of time previously necessary in doing it, but trouble was experienced because of a lack of rigidity of the circular planing tool, making it impossible to remove all the stock at one cut on some of the larger boxes. Another disadvantage was experienced in that in machining the cellar fits only one cutting tool on the planer could be used at a time. To obviate these difficulties the device shown in Fig. 10 was designed, having two tool heads similar to a planer head working in a horizontal plane, the tools being held in a cutting position by a coil spring, this arrangement permitting them to clear on the return stroke. The tools are adjusted to any size of box by moving in or out, as occasion demands, and the mechanism has afforded a simple and inexpensive home-made tool for the work. By utilizing this in connection with the Pedrick & Ayer planer about one-third more work has been turned out than was possible during the same time by the older method.

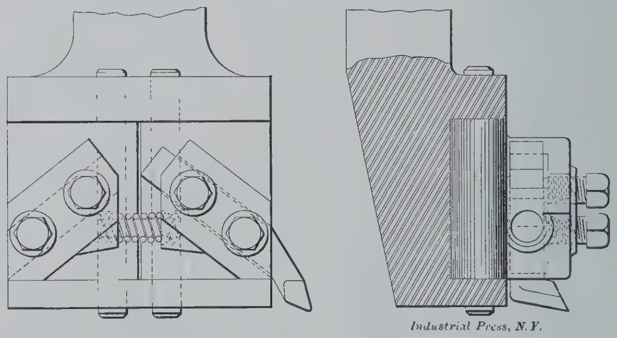


Fig. 10. Double Planer Tool for Driving Boxes

DRILLING JIG PLATES.

AN ORIGINAL METHOD FOR ACCURATELY SPACING DRILLED HOLES.

J. R. GORDON.

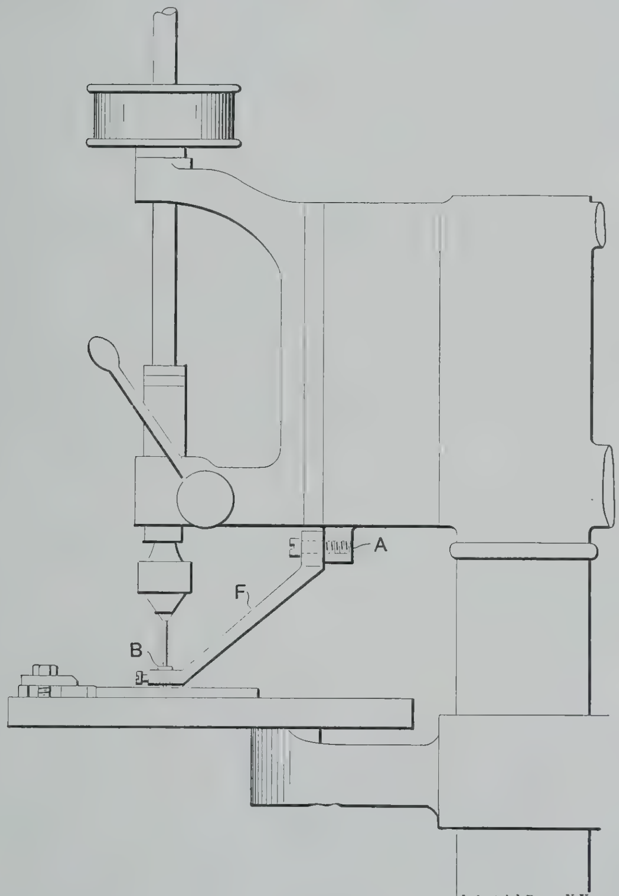
The method of drilling the holes in plates of jigs here described is to the best of my knowledge entirely new, and as I am associated with several toolmakers, of wide experience and acquaintance, who are of the opinion that the method is well worth introduction into general use, I offer it to the consideration of the readers of MACHINERY.

Having a large number of jigs to make and desiring to have the positions of the drill bushings accurate to within .001 of an inch, I removed the work table from an ordinary sensitive drill press of the usual pattern, and substituted therefor one of larger dimensions, to accommodate the size of the jig plates.

This table was first planed on the face and edges, and the stem, by which it is held in the bracket on the column of the press, was turned to fit snugly the hole in the bracket.

After planing and turning the table a series of holes was drilled, as shown in Fig. 2, and they were tapped to receive a No. 14-20 screw. Two parallel pieces *C* and *D*, Fig. 2, having straight edges and a thickness of ⅜ of an inch, were made and are to be clamped to the table in such position as may be desired or the work determine, the series of holes permitting any adjustment within the range of the table.

In order to make more room between the spindle and the column of the drill press the spindle head was blocked out, the block having a projecting lug as shown at *A*, Fig. 1, to which a bracket, *F*, was fastened to carry the bushing, *B*. This bushing is fastened by a screw and can readily be removed to insert others having various sizes of holes, if found desirable.



Industrial Press, N.Y.

Fig. 1. Drill Press Arranged for Drilling Jig Plates.

These preparations were all that were necessary with the exception of the gages that will be described in the operation of the method for spacing, which is as follows:

The plate to be drilled had a number of holes spaced as shown in Fig. 2, and before drilling them I marked them out as Nos. 1, 2, 3, etc., No. 1, as will be seen, being the upper right-hand hole. Its location with reference to either end or sides of the plate did not require to be very exact; but other plates may need to have the holes placed at some definite distance from the edges or ends so I will describe this one as having the distance 6 inches from the edge, *G*, and 8 inches from the end, *H*.

With these distances given I then make two gages, using vernier or micrometer calipers for my standard, and make them 6⅛ and 8⅛ inches long respectively. I then remove the bushing, *B*, Fig. 1, and in its place insert a plug having a diameter of ¼ inch.

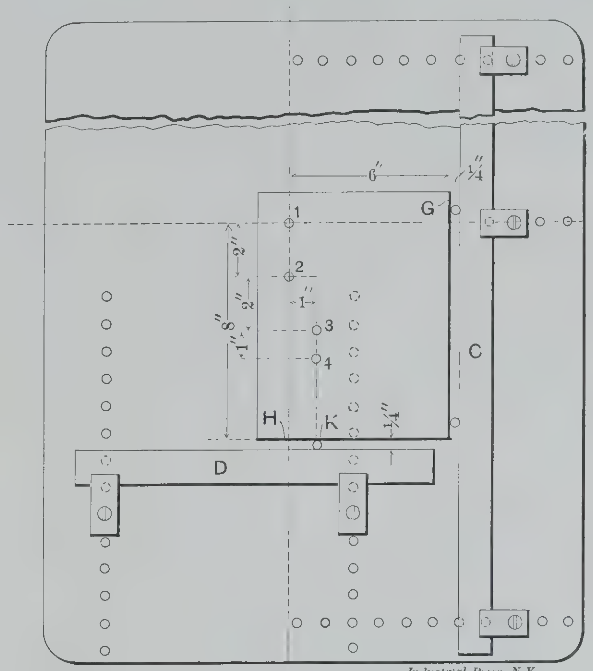


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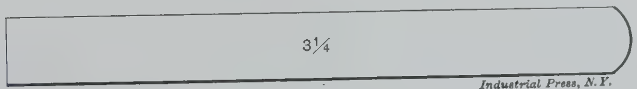
Fig. 2. Plate in Position for Drilling first Hole.

Resting the 6⅛ gage on the table, and with one end touching the plug, the parallel piece, *C*, Fig. 2, is brought to just touch the other end of the gage and is then clasped to the table. This is not much of a trick if one end of the parallel is left free and the other end is clamped tight enough to permit the free end to move somewhat stiffly. After locating and clamping the parallel, *C*, the other parallel is clamped in position, but it must be placed square with the first parallel. This is more of a trick than the first one, but is not at all difficult if one man can be employed to clamp the piece while another holds the square and gage.

The reason for making the gages 6⅛ and 8⅛ inches long instead of 5⅞ and 7⅞ inches respectively is that it is not desirable to have the edges of the plate touch against the parallels, as chips could get between the two and destroy the accuracy of the measurements; so I allow the gage to be ¼ inch longer than the distance required and fill the space in with ¼ inch diameter gages as shown in Fig. 2.

For gages over 1 inch in length I use flat brass rods or strips about ⅜-inch wide and ⅛-inch thick and cut them a little longer than the finished length. One end is finished square and the other end is rounded as shown in Fig. 5. In making the gage, if too much metal is removed it is an easy matter to pene the stock out to make up any reasonable error. The length of the gage is stamped on it, and when the operation is completed it is put away for future use.



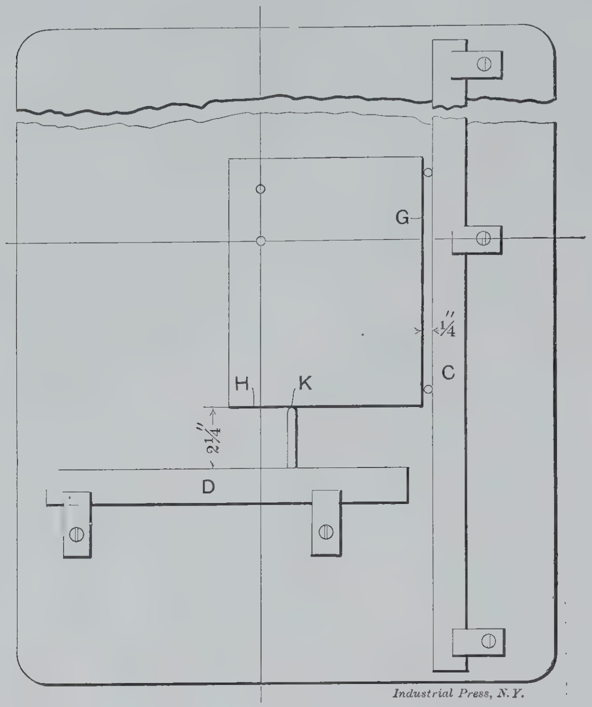
Industrial Press, N.Y.

Fig. 5. Gage.

Having located the parallels, the plug is removed from the bracket and the bushing replaced. The drill should, of course, fit as snugly to the hole in the bushing as it can and run without cutting. The bushing should support the drill to within a distance equal to the diameter of the drill from the plate to be drilled and care should be taken not to drill through the plate until all the holes have been started.

After drilling the first hole to place the plate for the second hole, distant 2 inches from the first, it is moved along the parallel, *C*, and a gage 2¼ inches long placed as shown in Fig. 3, and when so placed is ready for drilling.

The third hole requires three new gages, since it is 1 inch off the line of the other two holes, as shown in Fig. 4.



Industrial Press, N.Y.

Fig. 3. Plate in Position for Drilling second Hole.

For holes which are to be finished 3-16 inch to ¾ inch in diameter I first use a small drill, size No. 52 to No. 30. After the holes are all drilled to this size I then enlarge them, by the use of a series of four lip counterbores, to the required size. Where extreme accuracy is required, in the place of the counterbore, a small boring bar may be substituted and the holes bored to the size desired.

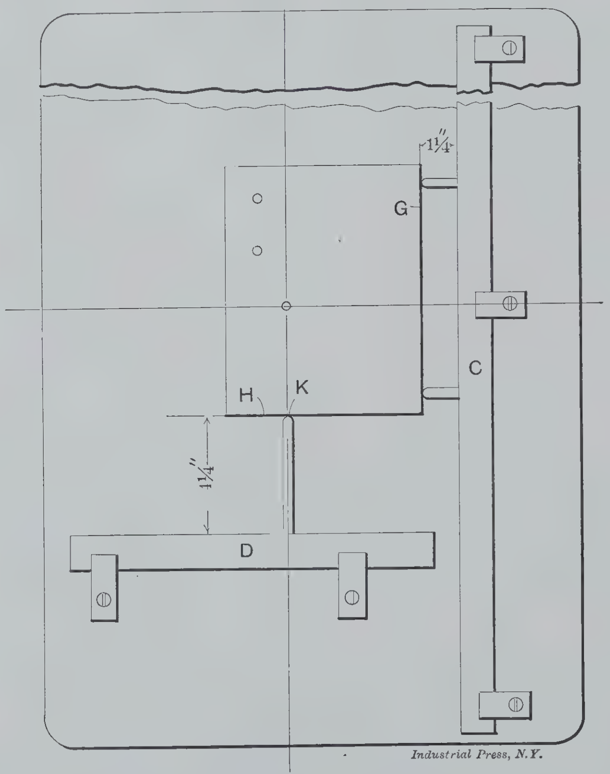


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Fig. 4. Plate in Position for Drilling third Hole.

One disadvantage of using a boring tool is that it requires a hole in the table equal to the largest hole to be bored out or that the plate shall be kept clear of the table by blocking up with parallel strips under it.

Fig. 6 shows a form of boring tool which I have found very convenient for use on this kind of work.

It consists of the shank, *A*, which is fitted to the taper hole in the spindle and a split holder, *B*, which is pivoted to the shank at *C*, and is locked to it at *D;* the screw at *D* serving to clamp the boring tool, *E*, at one end, while *F* clamps it at the other end. Adjustment is obtained by swinging the holder, the radial slot, *G*, allowing it to have quite a range and the stop screw, *H*, permitting fine adjustment. Split bushings in the holder will allow the use of boring tools of smaller diameter if desired.

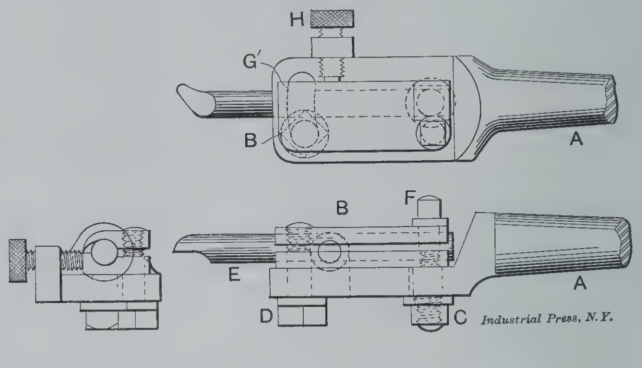

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Fig. 6. Boring Tool.

This method of locating holes is not limited to the drill press but may be employed to advantage on the faceplate of a lathe. In this case the work, as soon as located by the gages, is clamped to the faceplate.

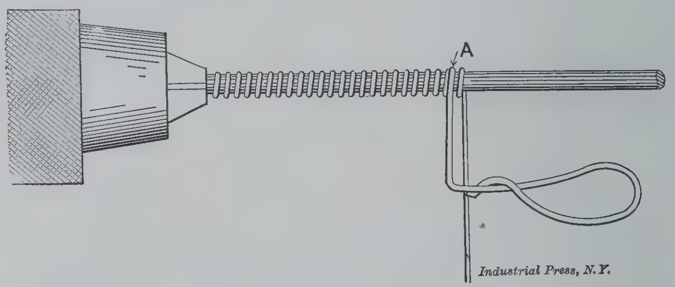
While this method was originated for drilling holes in jig plates, it may be used with equal success for drilling small interchangeable pieces. It is not necessary that the edges, *G* and *H*, be planed at right angles, as the same results will be obtained if the surface, *G*, is planed true and a finished spot provided at *K*, from which point all measurements to the parallel, *D*, are made.

* * *

WINDING SMALL SPRINGS.

P. A. Whitney sends us a little trap for winding small springs up to, say, No. 12 English standard gage, which is shown in the cut. It is accompanied by a spring, wound by this means, which is very regular and satisfactory.

The method for using the device is very simple. A drill rod, about 3 feet long, which is a little smaller in diameter than is wanted for the inside of the spring, is put in a drill chuck and a piece of wire of the size of the space between the coils of the spring is put in beside it and two coils are wound and cut off as shown at *A*. One end is twisted to form a loop for convenience of handling. Now place the spring wire in the chuck, with the rod, and after winding two coils by hand, screw the larger wire onto, or into, the coils thus wound. Then grasping the guide and the free end of the wire in the right hand, start up the lathe with the left. The free end of the drill rod should be grasped in the left hand to prevent its whipping around.



Industrial Press, N.Y.

Device for Winding Springs.

* * *

To indicate when the moving parts of the machinery have become excessively heated, a German inventor has devised a paint composed of an amalgam of the iodides of mercury and copper, which the inventor claims will change color when heated. Bearings to which it is applied are red under normal conditions, but when a temperature of 140 degs. Fahrenheit has been reached the paint becomes black.—*Electricity.*

LETTERS UPON PRACTICAL SUBJECTS.

SOME OF THE TROUBLES OF THE MACHINIST-ENGINEER.

Editor MACHINERY:

I have often noticed in the past, advertisements worded something like the following:

WANTED—An engineer. Must be used to ——— engine, and be a machinist able to do his own repairs, and repairs for the factory machines. Will pay $12 per week.

Whenever I come across such an advertisement as this (and I am sure that your readers have often done so) I wonder what kind of a *rara avis* the man who inserted that "ad" expected to get from the ranks of the unemployed. Now I have seen some mighty handy fellows in the machinists' ranks, but I speak advisedly, I think, when I say that I never saw a man who could fill both positions as they should be filled.

Let us see what is liable to be one day's work for the average engineer. He comes in before anyone else is thinking of starting to work, and putting on his overclothes begins to get up steam. In the meantime something about the engine must be fixed before it can be started, and by the time he has done that it is time to begin to oil and warm up the engine. Soon after starting, a water glass bursts and that must be replaced. Then the Boss wants his lawn mower fixed, or the kerosene stove is out or order. Then he is called to the office to fix an electric bell; and then to repair a bursted pipe or a damper regulator, and in the meantime receive a visit from the boiler inspector making internal inspection. Perhaps also he has to meet courteously two or three oil men and steam packing agents. Some time during the day he has to clean out his spare boiler, find out for the Boss how much power a certain room is using, and because it is thought he is using more coal than he has previously, it will be necessary to take some indicator cards. The Boss thinking that the present will be a good time to stock up with coal comes in and wants to know how much coal the bin will hold, and so he has to measure the bin to find that out. Fortunate is he if he keeps a journal and can refer to that when some of these questions come up. And thus it goes throughout the day. If he happens to get a few minutes to sit down and cool off, during which time he possibly studies the slide rule, or the laws of combustion, etc., some old woman or other (as happened to me) will come in and say: "Then all you have to do is to sit here and see that thing go!" (I don't quite know what she meant, as I have machinery going in three rooms and had already shoveled two tons of coal), but I told her "Yes, that was all."

Now, Mr. Editor, I have had about thirty years' experience as an engineer and some of it has "stuck," but I think the man who writes an "ad." like the above knows little of what an engineer's duty is. It has always seemed to me that an engineer must be born to love his profession, for profession it is and one to be proud of. As for myself I prefer it to anything going.

In connection with this I will tell of an incident that happened in a neighboring city. A certain firm had contracted for an engine of the cross-compound non-condensing type. In due course of time the engine arrived and also a machinist to set it up. It was duly erected (and well done too). When ready it was started up by the man who had erected it, and after it had run awhile he proceeded to take some indicator cards from it. He took some from the high-pressure cylinder and sat down on a box and began to pull his hair seeming strangely excited. The chief engineer of the plant noticing his apparent trouble interrogated him: "What's the matter?" quoth the chief. "Back pressure?" "Yes," answered our friend, "there seems to be back pressure on this high-pressure cylinder." "How much?" "About one-half inch." "Well," answered the chief, "it surely must be some 'inherent' fault of the engine, for the piping is all right." The erector who did not seem to take in the full meaning of the chief's "inherent" was sadly puzzled and informed the chief that he should write to the firm about it. I have often wondered what reception he got when he returned after complaining of back pressure on the high-pressure cylinder of a cross-compound engine.

OLD MAN.

CHUCKING PIECES.

Editor MACHINERY:

I am somewhat surprised in going into different shops to find how comparatively few use what can be called "chucking" or holding pieces, on castings which are to be finished in the lathe. While there are times when this can also be done to advantage on shaper work the application is much more limited than in lathe work.

A chucking piece is such a simple expedient and was so common in the shop where "yours truly" learned his trade that he never dreamed of its being new or novel in any part of the country, but this is the way with many other things also.

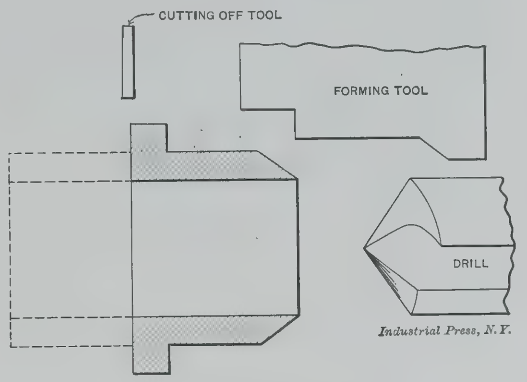
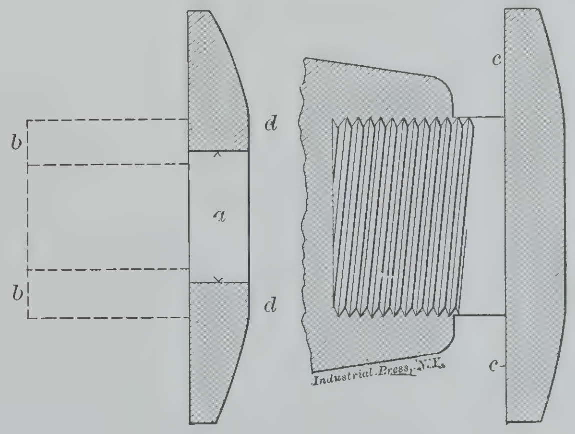


Fig. 1. Chucking Pieces.

You ask a shopman if he has anything new to show you, and he almost invariably answers no, but if you ask how he does this or that piece of work you are likely to find a new method or one that differs from your own practice. It is old to them, and they never think that it may interest you. But to return to chucking pieces.

Two examples will serve to show the application to those who are not already familiar with it. Fig. 1 shows a thimble, of brass in this case, with the chucking piece in dotted line at the back. Without this it would be necessary to chuck the piece twice, with the attendant trouble of getting it true the second time and the danger of marring or springing unless it was held in a split chuck. Of course a mandrel or arbor could be used, but this has troubles of its own as well.



Figs. 2 and 3. Chucking Pieces.

By adding the chucking piece to the pattern you have a place to grip in the chuck and the whole operation can be done without removing from the chuck, thus insuring the whole thing being concentric or true, and saving considerable time. In a turret or Fox lathe this is easily done, and the tools shown give a suggestion in this line.

By threading the chucking piece in a turret lathe and holding it in a screw chuck it is handier working than holding in a regular jaw chuck, and the cost of facing and threading the piece is very little. All the metal contained in this chucking piece goes back to the foundry as chips or scraps, so there is practically no loss on this account.

Fig. 2 shows a disk for a ball joint which was first made by catching in a chuck and tapping the hole *a*, at the same time facing *d* square with it. It was then put on a screw chuck and the flat side faced off, then reversed and the ball joint finished and the outer edge turned to size.

The addition of the chucking piece shown by dotted lines (this was cored straight through, same as disk) made it possible to face and thread the chucking piece in the turret lathe and hold in a screw chuck, Fig. 3, as shown. The whole thing could then be done in one operation and cut off complete. While the work might have been held in a jaw chuck, the screw chuck is better in many ways as it gives more room to work around and there is no danger of the work slipping. A Stillson or some similar wrench takes out the piece cut off, with little trouble.

Every shop manufacturing in quantities has many places where some modification of this method can be employed to advantage. R. E. Marks.

A TAPPING RIG—DIVIDING DEVICE FOR PLANER.

Editor Machinery:

I have been reminded to-day of a rig for tapping the feed screw boss of upright frames, that was made in my young days. It had almost faded from my memory, and lest it should do so entirely I send you a description of it at once in hopes that it may do others as good service as it did our firm. The appliance is shown in Fig. 1.

The drill frames, of which *A A* show the two upper bosses were previously bored and faced. The tackle for tapping consists of the tapping bar *B* turned to slide on the upper boss *A* and in a bushing *C*, the ends being threaded same pitch as the work to be done, and fitting an internally threaded bushing *E*. Both bushes had projections to correctly locate them, and were clamped against the faced ends of the boss by two bolts as shown. The "business" end of this bar is turned down (shown at *F*) eccentrically, and carries a head *G*, which is free to rotate upon the bar, but can be held in any desired position by means of the teeth formed upon its outside face and the teeth upon the inner face of the bushing *H*. The bushing is prevented from turning by the key shown and it can be firmly clamped against *G* by tightening up the knurled nut *K*. The cutter *L* is square and fits into a square hole and is locked by the square head screw *M*. When it is in the position shown it is at its outer limit, and when exactly opposite, it is at its extreme inner position. The head is rotated by means of the handle *N*.

In practice the head would be turned to bring cutter to such a position that upon turning the bar, by means of a long handle fixed upon the square at the end, a reasonable cut would be taken. Upon reaching the recess *O*, the knurled nut *K* would be unscrewed, disengaging the teeth and allowing the head to be turned right back until the lever *N* butts against the stop pin *M*. The bar would then be withdrawn and the head turned back to the same index position and advanced a notch or two. The cutter head would then be clamped and another cut taken, and so on until sufficient depth of thread is obtained. To gage, the bar is withdrawn altogether.

I can now see where several improvements might be made. Insert a spring between the head *G* and the bushing *H*, in order that the teeth would become free upon unlocking the nut *K*. Cut the thread out of the bushing *E* and introduce a disengaging nut. By lengthening the bar at the end *D* and adding gearing with quick action, or self-acting clutch, the bar could be power-driven. Instead of the nut *K* a quick cam action might be better. However, the principle of the thing is shown, and no doubt many improvements might now be suggested.

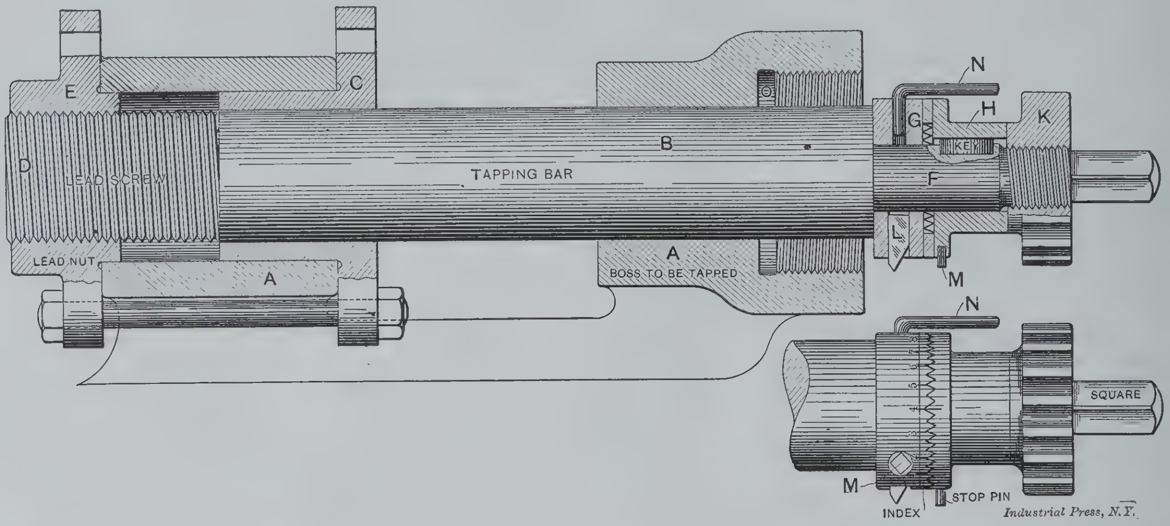


Fig. 1. Tapping Bar for Tapping a Hole Square and in Line with Another.

Another handy rig is shown in Fig. 2. This is an arrangement for feeding the cross slide screw of a planer in accurate intervals. This screw was ¼ inch pitch and the work necessitated the screw being rotated one and one-half time to feed the tool box ⅜ inch, which was the pitch of the ratchet teeth to be cut upon the work. After spacing by use of this tackle a correctly formed tool was fed in by means of the upright slide, a stop being provided to insure the teeth being cut to exactly the same depth as each other.

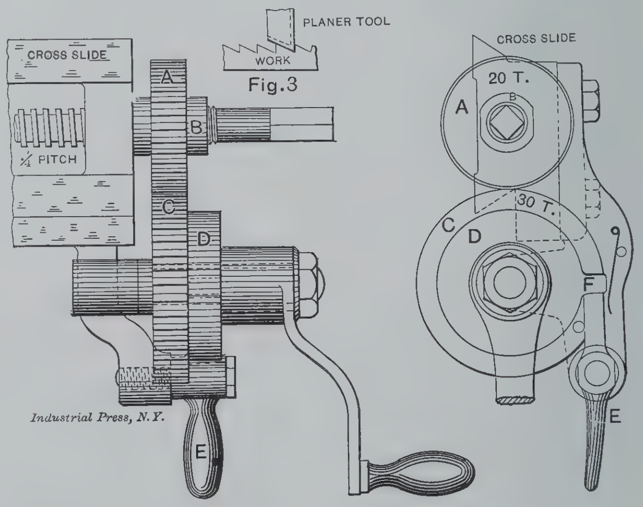


Fig. 2. Device for Feeding Planer Cross-slide for Rack-cutting, etc.

The pinion *A* is locked to the screw by the nut *B*, and meshing into it is a wheel *C*, which wheel has connected to it the stop disk *D*. The lever *E* is pulled forward allowing the stop disk *D* to be rotated by the handle. As soon as the stop *F* on the disk *D* has passed the lever *E*, the lever is allowed to spring back, and thus acts as a stop to prevent the disk being turned more than once round until the lever *E* is again pulled forward. One turn of wheel *C*—which has 30 T. and the piston only 20 teeth—rotates the pinion 1½ times, and hence feeds the tool box 1½ times ¼ inch, or ⅜ inch.

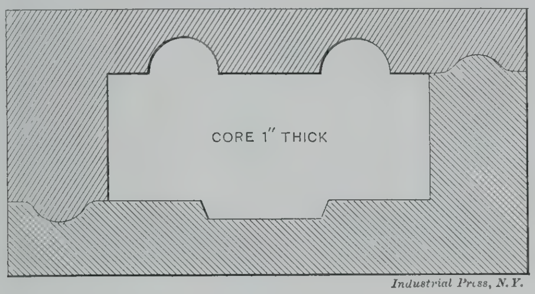
It would be possible to arrange the rig so that wheel in any ratio could be fixed in place of *A* and *C*, in order that any pitch could be cut, but to secure accuracy of division the disk *D* should always make one complete turn.

Birmingham, Eng. FRANCIS W. SHAW.

"TWENTY YEARS AGO"—PATTERNMAKERS' DOGS.

Editor MACHINERY:

In every issue of MACHINERY and other mechanical publications appear articles and illustrations of handy and simple mechanical methods for doing work which are studied and appreciated by the great majority of mechanics, but along comes some fellow who writes that he saw or used the same thing "twenty years ago." Well, suppose he did; if it is a good thing and he saw it "twenty years ago" is that any reason why others should not know of it?

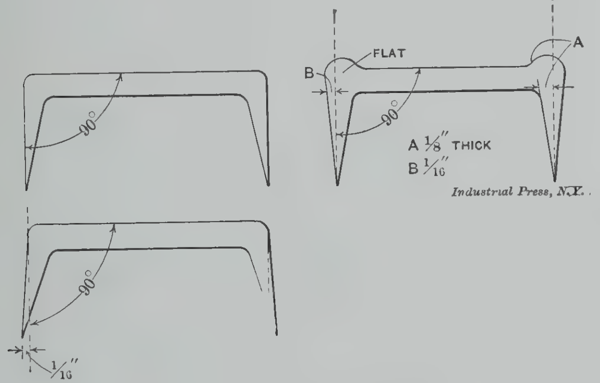


Industrial Press, N.Y.

Fig. 1. Simple Method of Making Core Box.

I send herewith sketch of a simple way for making a core box which may be old to some but new to me, and it may be to others. The core box, Fig. 1, was made in fifteen minutes, all done on a band saw.

The writer once had a number of boards to glue together, edge-to-edge, and to clamp them used the ordinary iron "dogs." I had two dozen clamps, but found only 7 fit to use, so I went to the workman next to my bench to borrow a few, but like myself he had only 5 in 3 dozen in order, and so it was with two other men; these iron "dogs" are used almost as much as any other tool in a patternmaker's kit and how few workmen keep them in working order.



Industrial Press, N.Y.

Fig. 2. Patternmakers' Dogs.

The patternmakers started in to discuss the "dog" question and what was the best shape and design for clamping and strength. Each man had his way for making a clamp, but no two men agreed that any particular "dog" was shaped right. I send sketch of a few "dogs" that each man had, and each thought his was just right. I would like to hear from some of your readers what their ideas are on the dog designs.

PATTERNMAKER.

A SCREW MACHINE CHUCK.

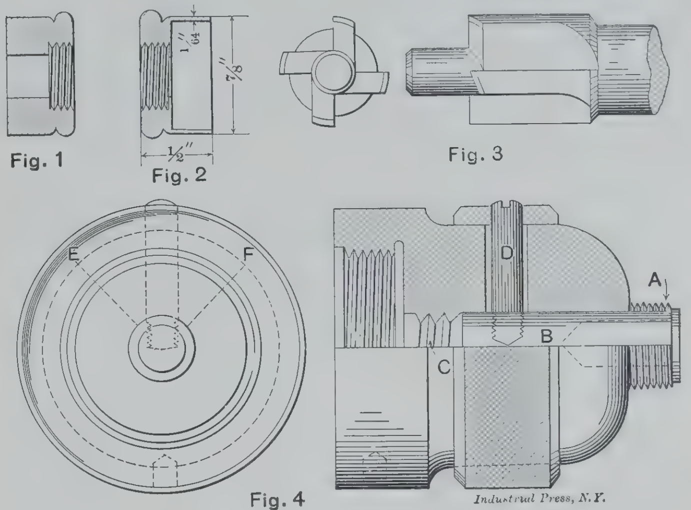
Editor MACHINERY:

A short time ago I had a screw machine job which seemed to present some difficulty but which was easily accomplished by use of the chuck here shown. The main difficulty came in performing the second operation, which left the piece with a wall of metal but 1-64 inch thick. Fig. 1 shows one of the pieces after the first operation has been performed and it is ready for the second operation, for which this device was constructed. Fig. 2 shows one of the pieces as completed by the second operation. This operation was performed by the counterbore, Fig. 3, the piece being held in the chuck shown in Fig. 4.

The end of the chuck was threaded at *A* to receive the tapped end of the work. Through the body of the chuck ran the plug *B*, which had a left-hand thread for fitting the chuck at *C*. A pin *D* connected the plug to a knurled ring on the outside of the chuck.

The pin *D* worked in a slot from *E* to *F* so that the ring could be turned through one-fifth of a revolution.

The method of performing this second operation was as follows:



Industrial Press, N.Y.

Screw Machine Chuck.

The knurled ring was turned until the pin *D* bore against the side of the slot *E*, when the work was screwed on the end of the chuck until it bore hard on the end of the plug *B*. The counterboring was then performed in the usual way. Now to release the work the knurled ring was turned one-fifth of a revolution, or until *D* bore against the side of the slot *F*, thus withdrawing the plug *B* from its bearing against the work which was left free to be easily unscrewed.

Syracuse, N. Y. HORATIO J. TAYLOR.

TROUBLES OF THE DRAFTSMAN.

Editor MACHINERY:

When an improvement and addition is made to a machine already being manufactured, every detail of the job is carefully planned out in the drafting room, even to the tools required for doing the work and the best manner of assembling. After a great deal of thought, many changes, and not a few misgivings on the draftsman's part, it is completed and put into the shop with full instructions for operating it; the work is finished, the assembling is successfully accomplished and the machine operates properly.

The passing machinist often thinks, "What a snap those draftsmen have. They simply tell us to do such and such things and *we* have to do the work. There seems to be plenty of room for each part; the idea is simplicity itself, anybody might have designed it, had he been asked to do so." Now this man probably wishes he were a draftsman; but if he knew the difficulties to overcome and the seemingly insurmountable obstacles that present themselves in the process of design, he might think differently. Suppose we give him an idea of the amount of work involved.

If someone invents an attachment for the machine, it is generally turned over to the chief draftsman in the form of a rough pencil sketch, giving no idea of either size, proportion or detail, and generally with no explanation whatever or, at the most, only a few words. The chief draftsman must then study it carefully until he has formulated in his mind an idea of how it can best be built and also something of the size and proportion of the parts to do the required work. He then takes a drawing of the machine, of one quarter or one-eighth size, and tacks a piece of tracing paper over it. On this he lays out the center lines and a few of the most important parts, designing, as far as possible, the best sizes of gears, pulleys, shafting, etc. If the improvement is to be put on a machine which has already been manufactured for several years there is very likely to be a scarcity of room; and this will sometimes necessitate the discarding of several different schemes, on each of which he will spend considerable time. When he finally "hits upon" a design which he thinks will do he calls up his best available man and explains the situation as completely as possible. This man proceeds to make an assembly drawing to the largest advisable scale, first drawing all parts of the original machine which will come adjacent to the new part, or to which it will be connected. At this point his trouble begins, for he soon finds it necessary to change the original machine here or there, to make room for this or that part. This he doesn't like to do for several reasons. It makes trouble in filling repair orders, the machine to be fitted with the new part may only be half done, or there may be a quantity of these particular pieces in the stock room. As a result it is generally necessary to make a compromise between two or more evils.

Next he may want to make a part which is not easily molded or machined, and then another compromise is required. And so it goes, deciding to make each part "so and so," not because it is just what he wants, but because it is the best that can be done under the circumstances; often taxing his mind at spare minutes for days, or even weeks, trying to think of some good way to overcome certain difficulties. Sometimes he thinks of a good plan only after the drawings are completed, when, if it is of sufficient importance, it may be necessary to redesign the whole machine. And sometimes he may think of it the minute he sees the completed machine in operation. I have seen instances where the new idea was enough better than the old to warrant throwing the first into the scrap heap.

But I am digressing a little. To go back to where the drawings are finally completed and approved by the superintendent, they are then sent to the pattern shop where it will be necessary to watch the patternmakers carefully, else they will surely get you into trouble. It must now be decided, by ascertaining the stages of the work already in the shop (unless this has been predetermined by existing circumstances) with which lot of machines to make the change, and then inform the head of each department as fully as possible of that part of the change which will affect him. He must be careful to tell him which lot will first have the change and all the original parts which will be left off or changed in any way.

The best time to make the change is on a lot for which the shop orders have not been sent out. The instructions can then go with the orders, making it comparatively easy. Generally, however, this cannot be done as the improvement is wanted on the first machine possible, even at the sacrifice to the scrap heap of some parts already made. In this case it is sometimes necessary to start some parts in the shop before the drawings of others are fairly finished. It is also necessary to call in from the shop all discontinued drawings and patterns, to avoid the possibility of mistakes which may arise from using the wrong ones. This cannot be done until all machines without the improvement are completed, complicating matters still more by making it necessary to remember just what has been done and what not done, out of a long list of changes. If a complete list be made of the things to be done for each change then as each is finished it can be checked off.

It is always best when a drawing is in process of construction to consult with the heads of the shop departments. Their ideas as to the way in which a piece can best be made are worth a good deal, and they are then more willing to make the change when it comes and have probably already made their plans for doing the work.

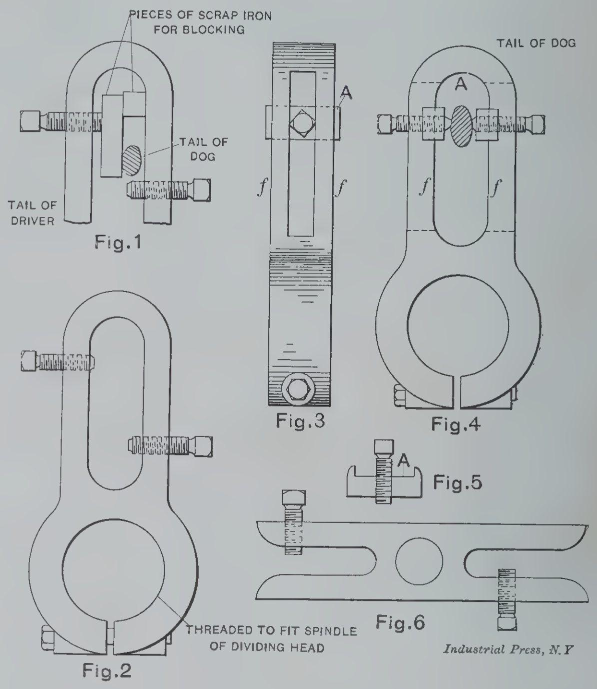
FRED S. ENGLISH.

IMPROVED DRIVER FOR MILLING MACHINES.

Editor MACHINERY:

The milling machine of to-day is, I believe, considered to be the best all-around tool in the modern machine shop and probably is the one that is kept most strictly up-to-date by the manufacturers. I have found, however, that there is one feature on at least two of the best makes that is defective and that is the driver for the dividing head. And this is now constructed it is more a case of luck than design that the set-screw of the driver comes in the proper place to bind the tail of the dog, as is necessary to prevent back-lash when using the dividing head. I have often found it necessary to clamp the tail of the dog in the "toggled-up" shape illustrated in Fig. 1. This of course takes time and makes a very unsatisfactory arrangement.

Having charge of several milling machines, I was free to make such changes and improvements as were found necessary to increase the efficiency of the machines. Fig. 2 shows the style of driver that came with the machines. This driver was quite unsatisfactory for the reason just given and also that the set-screws were not opposite each other. This is often a very desirable feature, as it is mighty handy to be able to loosen one screw and tighten the other slightly on the tail of the dog to shift a piece a little. Figs. 3 and 4 show the improved form of driver that I designed. A pattern was made for the castings and the slots were cored out. These slots were for the sliding nuts *A A* for the set-screws, the idea being to shift the set-screws along the slot to bear on the tail of the dog wherever it was and have both set-screws in alignment. Fig. 5 shows one of the sliding nuts of which there are of course two made for each driver. The inner edges and sides of the slots in the driver (where marked *f*) were machined on a shaper.



Improved Driver for Milling Machines.

The familiar form of driver shown in Fig. 6 was also fitted with sliding blocks or nuts in the same manner. It will be seen that this design makes a driver universal within its limits and that the tails of all dogs used can be properly clamped regardless of their length or position. If a dog is used having a bent tail it can be clamped without trouble between the two set-screws when these are pointed, without causing any twist on the work.

Chicago, Ill. ROBERT A. LACHMAN.

JIGS.

Editor MACHINERY:

The causes for the use of jigs may be summed up under three heads, the order in which they are stated representing fairly well the frequency though not necessarily the importance of the inference of these causes: First, reduction of cost; second, duplication; third, accuracy. We will take first the question of cost.

As no article can, as a rule, be sold in open competition with similar articles unless its cost is somewhat proportionate to the quality of its competitors, commercial considerations demand that the cost be kept as low as possible, while the quality be kept as high as possible. And jigs are one of the chief agents of this in metal work. When a jig is considered, the first thing to be settled is whether it can be made to pay, and if so, how much. The answer to this often involves very many other questions but can generally, if not always, be resolved into computations based upon the number of pieces to be made, and the probable cost of labor per piece when made with and without a jig; and the cost of the jig including maintenance. Also the fact that often a much less valuable machine or one less busy can be used with the jig, may be an important consideration. If no other factor than cost of production is involved, and it is found that the total cost of the jigged work will come very near that of the lot of articles when made without a jig, and no further order is in sight, it is pretty safe to abandon the jig idea; for it is apt to partake very much of the nature of an experiment, and the odds should be decidedly favorable to warrant the risk.

The second reason—the duplication of pieces—has a somewhat different foundation, though cost enters here also, as will be seen later. Suppose the part to be made is subject to wear or breakage, as in agricultural and textile machinery, guns, bicycles, etc. We know the strong disinclination anyone has for buying a wheel the makers of which have gone out of business. It is at once recognized that repair parts cannot be bought from stock dealers, but must be made at excessive cost and delay. So we have before us the importance to manufacturers that the buying public shall have confidence in the interchangeability of parts in order that sales may be made at all upon the open market. It is a fact that where this reason holds good, there is also the reason that costs will be lessened, because production of large numbers of parts is taken for granted. And in considering whether or not a jig shall be made this combination of reasons militates strongly for the jig.

There is also another reason for jigs, based on costs and interchangeability—it is that in fitting and assembling, those parts which are exactly alike require the minimum labor in putting in place.

In the third place, accuracy is often attained only by the use of jigs. There are jobs which could not be finished at all within the limits of accuracy demanded if jigs of some sort were not used.

It will therefore be seen that the determination of whether a jig shall be made may rest upon a number of questions which often demand great care and practical experience to solve in the way best meeting the requirements of the case.

F. M. B.

HANDY DEVICE FOR STARTING THE THREAD.

Editor MACHINERY:

I send a drawing of a device for holding up a valve against the pressure of the spring, for convenience when screwing the valve stem in the valve seat. Many water cylinders for steam and power pumps are so constructed that it is difficult to start the thread on the valve seat, owing to the pressure of the spring, as it is impossible to get both hands in the cylinder at the same time. The device will no doubt be handy for men who are repairing or even building machines of this kind.

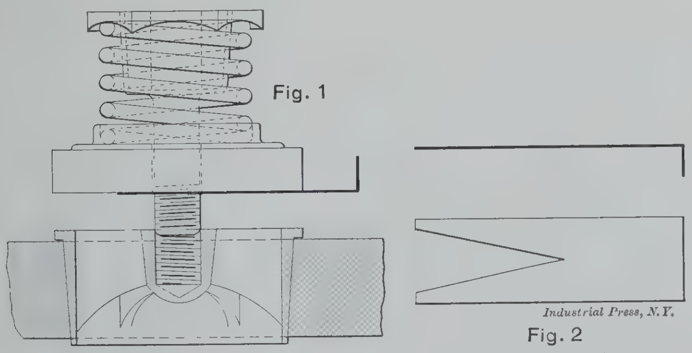


Fig. 1

Fig. 2

Device for Holding Coil Springs in Compression while Starting the Thread.

Take a piece of brass, or of sheet steel, of the shape shown in Fig. 2. Now take the valve in the left hand, press it up and then slide the forked-shaped piece under it in the thread of the valve stem. This will hold up the valve as in Fig. 1. Use one hand to turn the valve and the thread will enter the valve seat. Once the thread is started in good shape the brass fork can be pulled out and the operation continued in the usual way.

It will readily be seen that this device is very convenient in a "tight" squeeze.

C. W. PUTNAM.

Holyoke, Mass.

ADJUSTABLE FACEPLATE FOR THREADING ANGLE FLANGES.

Editor MACHINERY:

We have at times a good many angle flanges to machine for our boiler shop (Struthers, Wells & Co.) and no two angles seem to happen at the same time. The annoyance caused by and the time lost in blocking up some makeshift contrivance led us to make an adjustable faceplate for the lathe which works on a pivot through which a 1¼-inch bolt fastens it at any desired angle.

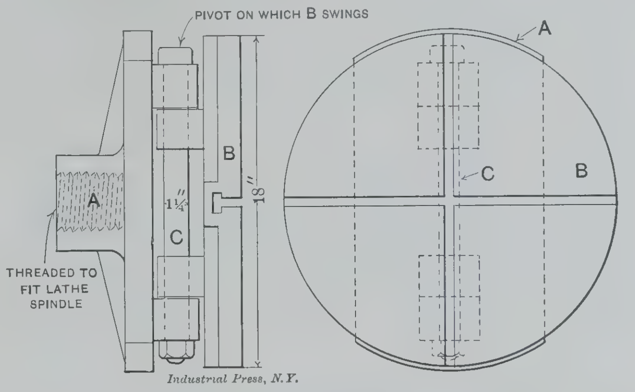


Fig. 1. Adjustable Faceplate for Angle Boring.

The plate *A* with the pivot lugs is cast in one piece, and is threaded to screw onto spindle of lathe. The illustrations, Figs. 1 and 2, show quite plainly its construction and adaptation. By placing the flange to be machined against the faceplate *B* and holding it in place with a pipe center, such pieces can be secured ready to operate on in about three minutes.

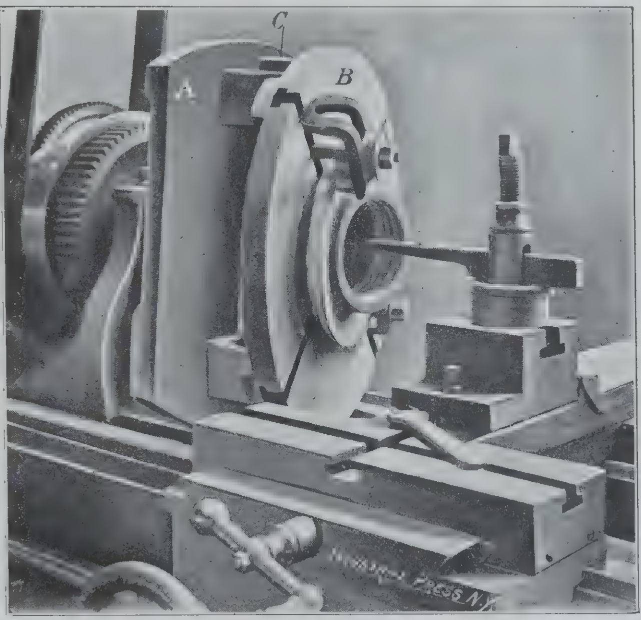


Fig. 2. Adjustable Faceplate for Angle Boring.

Warren, Pa.

A. A. AVERY.

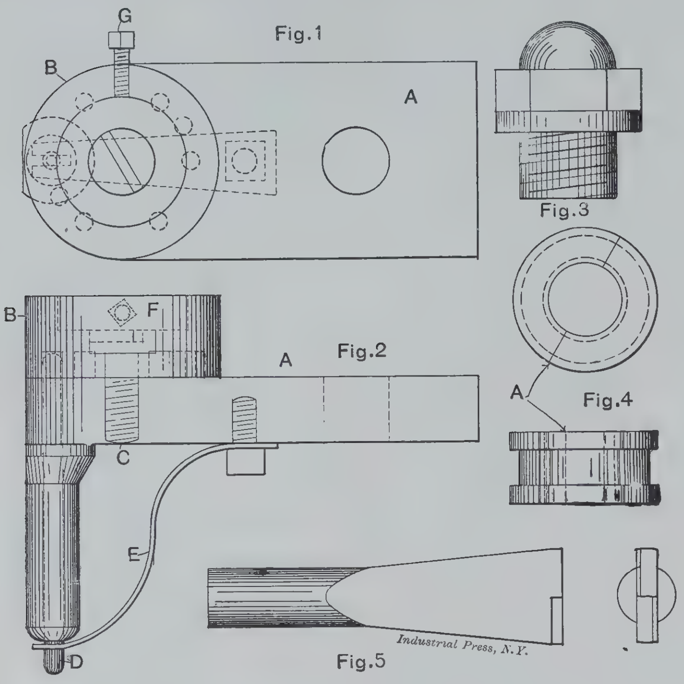
A TURRET ATTACHMENT FOR THE LATHE.

Editor MACHINERY:

A very convenient attachment for holding pieces to be milled is shown in Figs. 1 and 2. This attachment is used on the lathe carriage in place of a tool post. The steel head *B*, which revolves on the central stud *C*, has a number of holes drilled in the bottom to correspond with the desired spacing of the surface to be milled. A spring pin *D* slips into these holes as the head is revolved and holds it in position, while the work is being performed.

Fig. 3 shows a sample of the work for which this attachment is adapted.

The plug here shown is to be milled on six faces. The threaded end is screwed into the steel ring, Fig. 4, and the ring placed in the recess *F* of the turret head. This ring is split at *A* so that it may be firmly clamped to the plug by the set screw *G*, which also fastens it in the turret head.



Turret Attachment for Lathe.

Having clamped the work in the turret, it is fed up to the cutter by means of the cross-feed screw, while the rise and fall attachment of the carriage furnishes the means of vertical adjustment.

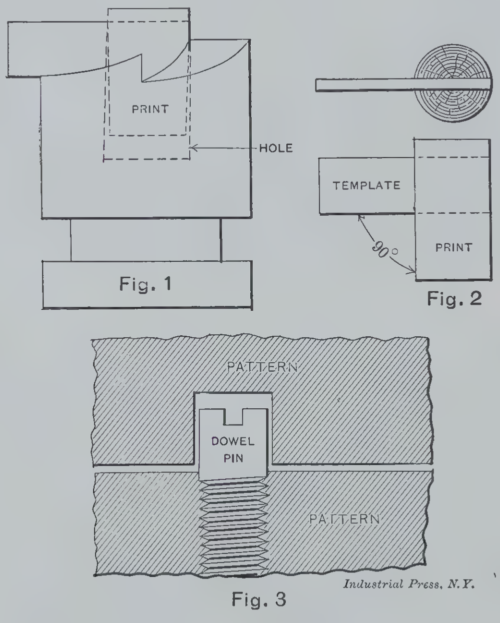
A good style of cutter for this work is shown in Fig. 5. It is held by a clutch on the live spindle of the lathe.

Connersville, Ind. E. M. Burgess.

MAKING A CLUTCH PATTERN—PATTERN DOWEL PIN.

Editor Machinery:

The sketches, Figs. 1 and 2, show a simple template for working the jaws of a clutch pattern. The writer has made several clutches and found this to be a simple and true method to get the jaws correct. I make the block fast to a faceplate with screws, then turn the outside diameter, bore a hole the size of inside diameter and about 1 inch deeper than bottom of jaw, turn a pin or core print to fit the hole, and on this print put a thin piece to act as a template. The print can be put in the hole and revolved round, showing where to trim the teeth, then removed when trimming is being done. A neat, perfect job can be done in this way.



Making a Clutch Pattern, etc.

The writer had a number of small split patterns to make in which it was a difficult job to put dowel pins. After one of the patterns was in the foundry a few days it was returned to have the pins made fast; the dowels were 3-16 inch diameter, ¼ inch long. I saw that wood dowels would not stand the racket, so I made the pins from common wood screws. They not only answer the purpose as dowel pins, but the molder prefers them to wood pins, as they do not swell. I drill a small hole just large enough to turn screw without splitting pattern. I grind the head as shown in Fig. 3, leaving slot.

Chicago, Ill. Patternmaker.

"PISTON HEADS AND PACKING RINGS."

Editor Machinery:

In the July issue Mr. Dunbar writes interestingly on piston heads and packing rings, and in the main, correctly I believe. I fear, however, that he has made one or two statements that may produce a wrong impression, on the younger readers especially, unless supplemented with some explanations that I will venture to give, seeing that no one else has done so to date.

In Figs. 2 and 3 of his article, the writer shows the correct and generally followed method of putting in Dunbar packing rings. He says that it is customary to put them in as shown, to prevent the possibility of the square section ring dropping into the counterbore, should there be a chance of its doing so. Otherwise so far as he is aware there is no reason why they cannot be put in the opposite way if it were desired to do so. Now, in my opinion, it makes considerable difference which way Dunbar packing is put in, and that difference might be sufficient to decide its success or failure. If it is put in opposite to the way shown in Figs. 2 and 3, the steam can blow down through the openings between the ends of the square sections and up through between the ends of the L-sections, provided there is any clearance for the packing rings in the groove and, as Mr. Dunbar says, some clearance of course must always be given. But when put in properly the two rings break joints effectually by being forced against the inner walls of the packing grooves. Of course if the rings are put the other way steam should not blow by the piston since the rings at the opposite end should stop it. I think, however, that most readers will agree that it is not good practice to have the steam blow through one set of rings to be stopped by the other set, at each stroke of the piston. The life of packing under such conditions would be of brief duration.

The foregoing makes it quite evident that with Dunbar packing two rings or sets of rings, are vitally necessary for a tight piston, and I think the same holds true for the ordinary snap ring to a lesser degree. Mr. Dunbar's analysis of the action of packing rings in the grooves throughout a piston stroke, shows in itself that two rings are always required for good results in a steam engine piston. The pressure of the steam keeps a packing ring against the inner wall of its groove during the first half of its stroke at least and its momentum during the second half, if the steam pressure is not sufficient, which, however, it almost always is. The inertia and friction of the ring on the exhaust side of the piston also keeps it tight against the inner wall of its packing groove. So in theory at least the packing rings should have little tendency to side movement in their grooves where there are two, but when there is only one it is of course forced alternately from one side of the groove to the other at every stroke. I believe that two rings—no more—are needed in every steam engine piston. A third ring is of no more use than—(the reader can supply his pet comparison).

It should be noted that the action of the packing rings in a steam engine piston is quite different from that occurring in a pump piston. In a pump piston the rings are alternately forced from one side of the groove to the other irrespective of the number of rings, and this is one reason why they wear out faster in pumps than in engines.

Newark, N. J. F. Emerson.

LONG RANGE CALIPERING.

Editor MACHINERY:

The following problem in "long range calipering" and the way in which it was solved, is but a sample of the jobs which a tool-maker gets out here in the West.

We had a shaft 31 inches in diameter and 47 feet long. A hole, extending through the shaft, was bored 10¼ inches for a distance of 6 feet from each end, after which it widened out to a diameter of 21 inches. The shaft weighed 85,000 pounds, and as this was thought to be excessive a means of measuring the 21-inch portion was desired. I was first called upon to make a caliper that would measure the internal diameter 9 feet from the end of the shaft.

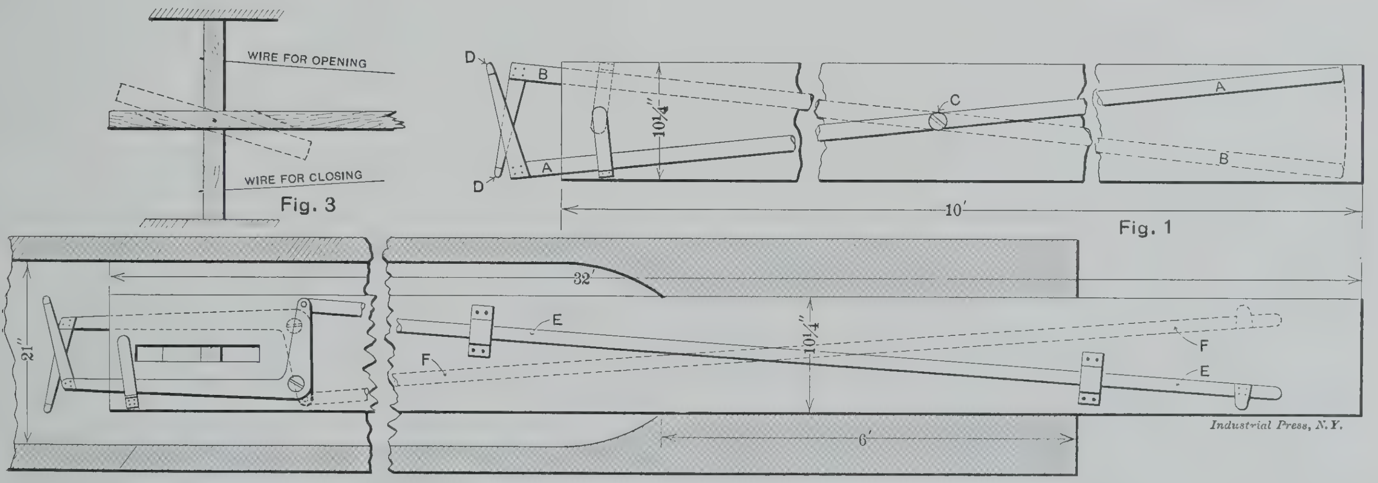
Fig. 1 shows the instrument which I constructed for the purpose. A board 10 feet long was fitted to slide snugly through the 10¼-inch portion of the bore. Upon this board were mounted the wooden caliper legs *A* and *B*, one leg being placed on either side of the board and both pivoting about the pin *C*.

The ends of these legs at *D D* were fitted with metal tips, so arranged that the extreme points were diametrically opposite. At intervals along the length of the legs small strips of glossy rubber were fastened, on the side next to the board, and these relieved any excessive friction between the parts and thus facilitated the operation of the instrument.

To use the caliper, it was pushed through the 6 feet of 10¼-inch bore, at the end, and up to the position where it was desired to make a measurement. The outer ends of the legs were then brought together until the inner points touched the inside of the bore. A mark was made for the position of each leg and the legs brought back to their original position. After the board was removed from the shaft the legs were set, by the mark, to the same position which they occupied when taking the measurement and the distance between the points was measured with an ordinary caliper.

It was, of course, unnecessary to withdraw the board for each measurement as any number of settings could be made, at different distances from the outside, and each set of marks given its respective number so that they could be re-set and measured after the board was withdrawn.

The caliper was used for this job with such success that a modified type, shown in Fig. 2, was constructed for calipering at greater distances into the bore. This caliper was 32 feet long, so that by working from both ends the entire length of the shaft could be measured. As will be seen in the figure, the legs are of the rocker type and are expanded by drawing the rods *E* and *F* outward. It was found that when the caliper was pushed in very far, so that it overhung the support for considerable distance, the measurements were not exact, owing to the sag of the board. To remedy this trouble a supporting stick was hinged near the end of the board, as shown in Fig. 3. This was operated by wires which ran to the outer end of the board. When the caliper was being inserted or withdrawn the stick was closed to the position shown by the dotted lines, and when it had reached the place where the measurement was to be made the upper wire was pulled and the stick brought up vertically until it bore firmly on the top and bottom of the hole. In this position the board was held central with the bore.



Long Range Calipers.

This arrangement was quite accurate, as a test measurement, at a range of 28 feet, showed an error of less than 1-64 inch. Within the tube, the caliper was more sensitive to sound than to touch, the chamber seeming to magnify the sound when the points came in contact with the sides of the wall.

E. J. BUCHET.

Dubuque, Iowa.

WHAT CAUSED THIS BREAK?

Editor MACHINERY:

I inclose a photograph showing an arbor and the result of hardening it.

The lower figure shows the arbor before it was hardened. It was 4¼ inches in diameter at the larger end, 2¼ inches at smaller end, 24 inches long and weighed 57½ pounds. I turned it from a bar of Sanderson's special annealed steel, No. 4½, without forging. On being hardened it broke as shown in the upper figure.

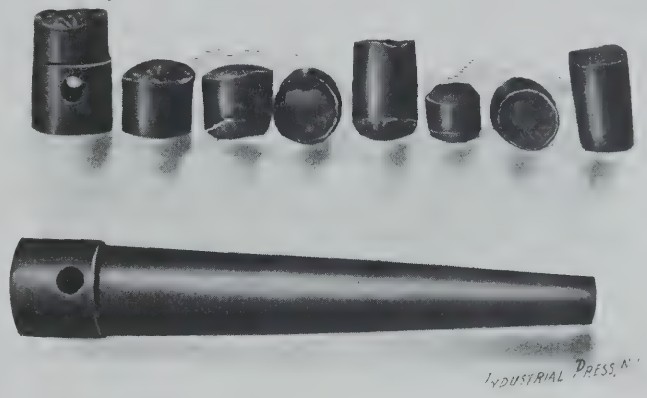


Fig. 1. The Arbor which Broke in Hardening.

Can you tell me what caused the break?

E. J. BUCHET.

Dubuque, Iowa.

We referred the above to our correspondent, Mr. E. R. Markham, of Springfield, Mass., from whom we received the following reply.—[EDITOR.]

Editor MACHINERY:

I have examined photograph sent me of broken mandrel. In order to examine the grain of steel from a photograph it is highly important that a section of the steel be magnified many times when photographed, whereas, the photograph shows the mandrel less than one-eighth actual size. But having had some experience in hardening similar pieces, and having had occasion to look up breaks similar to the one referred to, I will recount some of the causes of steel breaking when hardening.

From the appearance of the fractures it is safe to say that the break was occasioned by internal strains. These strains may have been the result of rolling in the steel mill or of unequal heating when hardening. To anyone who has made a study of steel and the effects of hardening it is truly wonderful that it is possible to produce a metal capable of standing the immense strain a piece of steel undergoes when hardened.

A piece of steel when heated red hot expands very appreciably. When it is immersed in the hardening bath the opposite process takes place, namely, contraction. The more rapidly the piece is cooled the more rapidly it contracts. Now unless the piece of steel is uniformly heated the process of contraction must be unequal, and unequal contraction is what raises the mischief when steel is hardened.

If the strains were due to the processes to which the steel was subjected in the steel mill, then it is necessary to overcome them before hardening, if possible. Now a piece of steel may be annealed in the bar so it is very soft and works nicely. But in order to overcome the strains in the piece to be hardened, it should be annealed after it is cut to length and the outer surface removed. In the case of a mandrel of the form shown in Fig. 1 the piece should be roughed out to shape, that is, turned tapering, leaving it large enough to finish to grinding size after annealing. The annealing heat should surely be as high as the hardening heat, yet not high enough to injure the steel. The piece should be heated uniformly throughout, the small end should be no hotter than the large end, and the outside of the piece should be of the same temperature as the internal portions. This is as necessary when heating for annealing as when hardening. A precaution which has in many cases worked nicely with me consists in heating the piece of steel to a uniform red heat, after roughing to shape, then standing it on end on the anvil and giving it a blow or several blows, on the upper end with a hammer, or sledge, according to the diameter of the piece. Should it be sprung by this operation it should be straightened while red hot. It may then be heated for annealing. This precaution is not necessary with a piece of steel which has been forged, provided it has been hammered to upset any portion after the drawing operation had been finished. But in the case of a piece of steel cut from the bar and machined to shape without forging, my experience convinces me that the above method insures more satisfactory results, especially if the piece of steel be long.

When the bars are rolled in the steel mill the process is one of elongation from start to finish and the process of hammering on the end has a tendency to in a measure counteract the effects of this.

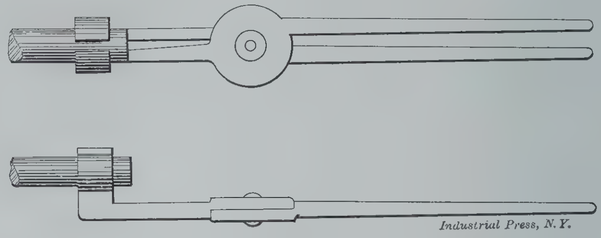
The process of annealing has the effect of overcoming the tendency to crack from the strains. It is an acknowledged fact among authorities on hardening steel that greater care must be exercised in heating round pieces than if the piece were of some other shape. This is because the circular form is the most rigid and offers the greatest resistance to change. For this reason it is necessary to observe extreme care, when heating for hardening, not only that the heat be the lowest possible to produce the desired result, but that it be uniform throughout.

A great many round pieces are cracked as the result of an uneven heat or one that is a trifle higher than necessary, while if the piece had been of another shape it would have come out all right. The fact that the mandrel is larger at one end than the other adds to the liability of its breaking unless the utmost care is used.

When heating for hardening a round piece should be rolled around frequently in order to get uniform results: because if left to lie in one position in the fire until hot it will be almost sure to have a portion along the entire length of one side that will not harden. This will be the case even if the piece is evenly heated. When the mandrel is heated to the proper temperature, and the heat is uniform throughout, it may be quenched in the bath. It must be dipped as near vertically as possible, dipping with the largest end down. The bath should be quite deep, at least 18 inches deeper than the length of the mandrel. The contents of the bath should be agitated from the sides, or a jet of water should come up from a pipe at the bottom to force the steam away from the heated metal in order that the water, or brine, can get at it.

When the red has disappeared from the steel, in the bath, it should be removed and plunged into a bath of oil and allowed to remain until cool. It should then be held over the fire and heated sufficiently to remove the hardening strains, which, in the case of a piece of steel of the shape shown, will be quite uneven, as the hardening will have penetrated much nearer the center at the small than at the large end.

When dipping in the bath it will be found advisable to use a pair of tongs of the form shown in Fig. 2, so that the cooling liquid may get at the center to harden that.



Industrial Press, N.Y.

Fig. 2. Tongs for Dipping the Arbor.

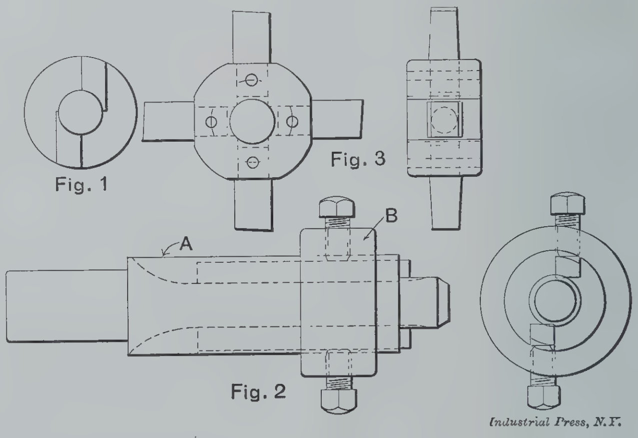
In some shops, where it is found necessary to use steel containing a high percentage of carbon, for cutting tools which must, of necessity, be extremely hard, it is a common error to use this high carbon steel for articles such as the one under consideration, whereas a steel much lower in carbon would answer the purpose as well and be less liable to break in hardening.

NOTES ON COUNTERBORES.

Editor MACHINERY:

The counterbore shown by Corneil Ridderhof in the August number of MACHINERY might be improved if the cutting edges were radial lines instead of tangent to an imaginary circle, the diameter of which is equal to the thickness of the cutting tooth. It will be readily seen, by referring to Fig. 1, that the cutting edges are radial lines and that the cutting teeth are offset enough from the center to form a support directly back of the teat, where the support should be. Counterbores are expensive small tools in almost every shop. Where standard work is done and there is no scale to contend with, the solid counterbore with milled teeth usually does the most and best work.

The writer had occasion to do some facing on rough castings and made a counterbore like the one shown in Fig. 2. The body *A* is slotted with a ¼-inch cutter to a depth slightly below the teat to receive ¼-inch square self-hardening steel blades or cutters. The collar *B* fits the body nicely and contains two screws which are brought to bear against the blades to hold them from end movement. Something over two hundred and fifty holes were swept with this device. The blades are easily removed for grinding, but with the self-hardening steel this was not often necessary, as it was ground but three times in doing this work. This style of counterbore could be changed for different diameters of holes by having bushings to fit the teat. Larger counterbores could be arranged for by placing liners under the blades or by making the blades wide enough to suit the diameter.



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Counterbore and Milling Cutter.

We had some taper slots to mill which were 1 1-16 inches deep, 11-16 inch wide at the top and 9-16 inch at the bottom, and as the job would not permit the use of an expensive cutter, a cheap cutter was made which answered the purpose very nicely. The cutter is shown in Fig. 3. A machinery steel collar 2½ inches in diameter by 1½ inch face was bored ⅞ inch to fit the milling machine arbor. Four holes were drilled into it and reamed ⅝ inch. The cutting teeth were made of ⅛-inch square tool steel, turned far enough back on one end to drive lightly into the holes reamed in collar. Stubs steel pins 3-16 inch in diameter were driven through the collar into these pieces to act as dowels. After the teeth of the cutters were turned they were taken out and the clearance filed. The cutting end was hardened and the teeth were driven into their places. The teeth did not come back to their original position after driving them in the second time, but an oil stone soon fixed the edges so that they all cut uniformly and the work done was very satisfactory. Shop cost of cutter, $1.20.

C. Arbon.

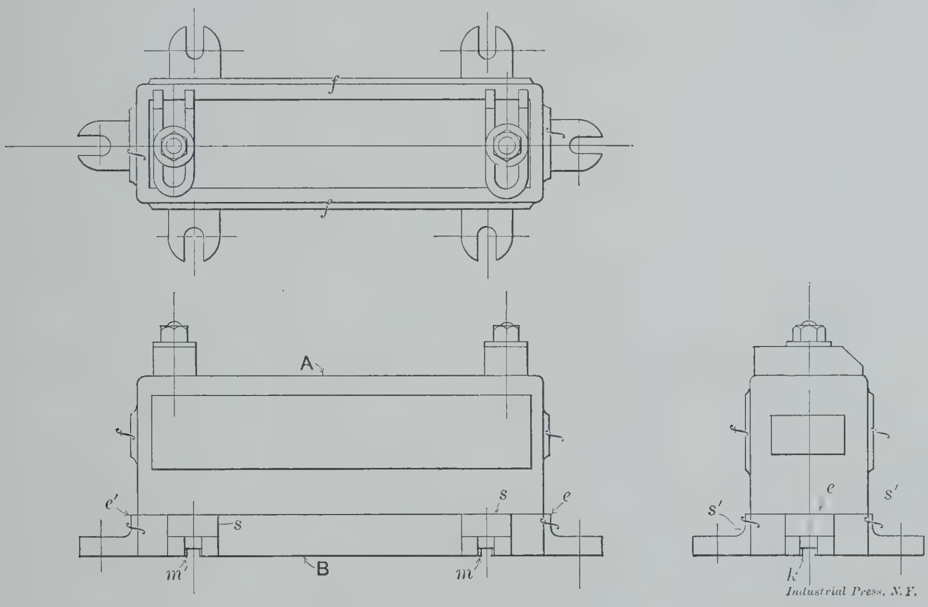
A MILLING FIXTURE.

Editor Machinery:

The accompanying drawing and description show a method of milling pieces in duplicate, where several faces are surfaced, which reduces the setting of the machine and handling of the work to a minimum.

Let *A* represent a piece to be surfaced on spots shown on sides and ends, these surfaces to bear definite relations to one another. It is quite possible to put spotting pieces on top or bottom and finish these first, fasten the work to the platen and finish a side and then by parallels and squaring plates finish the other surfaces from the first. But this means a good many measurements, bolts, straps and settings of the machine, the mass of which may be avoided by the fixture shown.

It consists of a casting *B* to which the work is fastened in any convenient way after being located by the spots e e^1, s s and s^1 s^1, which are finished to the dimensions of the finished work, and serve to show the necessary position of the work in order to clean. The fixture has on its lower side a key slot k corresponding to the slot in the machine platen and spaced equally between the opposite spots s s and s^1 s^1 on the side.



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Fixture for Duplicate Milling.

In setting up the machine, the fixture is located by the key, and the cross-feed screw is used to bring spots s s or s^1 s^1 to the line of cut of a face mill on the spindle nose. As the slot k is located centrally between the sides to be milled, the same setting of the machine answers for both sides, it being necessary only to turn the fixture around. The ends are gotten in the same way and without altering the setting of the machine, for the slots m m^1 near the ends of the fixture are the same distance from surfaces e e^1 as is slot k from surfaces s s and s^1 s^1. Therefore, the operator has simply to see that the key enters the slot fairly.

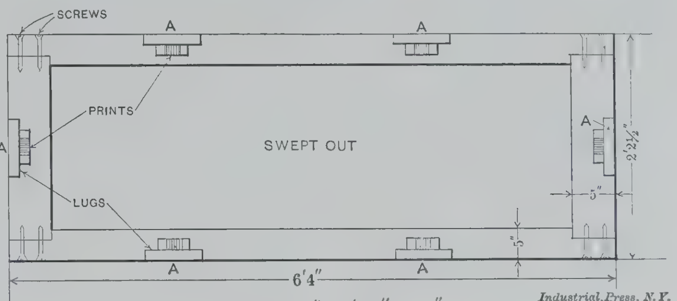
Ears may be provided for receiving the bolts which, when loosened, may simply be moved to suit the new position of the fixture as it is swung around. In practice one side may be milled, then an end, a side, and an end; one rotation completing the piece. On many jobs the key and slots would not be accurate enough, in which case a sole plate upon which the fixture might be located by dowels could be brought into service. The principle, however, would remain the same.

B.

HOW FOREMEN DIFFER.

Editor Machinery:

The construction of a pattern is at times a difficult problem, not so much in making the pattern, but in constructing and finishing to meet the wishes of the foreman, when no instructions are given as to how the job should be done. While working in an eastern shop I was given a pattern to make as shown in sketch. The only instructions given me were, "*Only one casting is wanted.*" I cut the lumber to size, dressed it down to size on planer, and did as little hand planing as possible. The frame I did not touch with smooth plane, just put it together as it came from the planer. The corners were put together as shown, all parts were screwed and no glue used. I did no waxing or puttying, and the pattern was O. K., also the casting.



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SKELETON FRAME 6'4" X 2'2½" X 1¼" THICK

A few months after I quit this shop and went to work in another in the same town. The first job of pattern work was almost the same as the pattern I write about. One casting was wanted. I constructed it the same as the other, and when finished notified the foreman.

He at once gave me a general "*calling down.*" First, the work should be made smooth with smoothing plane; second, the corners should be one-half checked and glued; third, all screw holes and openings waxed or puttied, and fourth, if I knew my business I would do this without being told. When the foreman was done "*calling me down*" I said I would finish the job and quit. He insisted on my remaining at work, but I could stand no such unreasonable abuse as that. A foreman of this type is a disgrace to any shop. When the proprietor or superintendent of a factory finds he has a foreman in his employ who is always finding fault with his workmen, the sooner he gets rid of him the better it will be for his shop, bank account, and workmen.

After leaving this man's employ I made it my business to tell every good mechanic the sort of a boss he was, and I can assure you he had his troubles getting good workmen. A number of men who are to-day placed over good workmen, as foremen, were intended for the police force by nature.

Patternmaker.

A WORD REGARDING CORRESPONDENCE SCHOOLS.

Editor Machinery:

Now and then I have seen much written for and against the efficiency of teaching by correspondence, and the schools established for that purpose in particular. Taking it as a whole it appears that both sides are right and it only reminds me afresh that there could hardly exist an educational institution that would not be criticized on some ground or other. I remember hearing a Cincinnati machine tool builder tell of a young man who was in his employ between terms in college and he asserted that every time this young man came back from college he had to start to learn the trade all over again, having forgotten nearly all he knew.

As the college which this young man attended has a fairly well equipped machine shop, and part of this student's time was spent there, this is somewhat surprising, but the chances are that the fault was more with the student than with the college. One thing I noticed is that many who do not believe in correspondence schools seem to forget that these schools can do the teaching only, the learning being the student's part of the programme and the institution is certainly not responsible for the failure or neglect of the "party of the second part."

That the agents of these correspondence schools often assure stupid men of their ability to become machinists, draftsmen or even mechanical or electrical engineers, in their efforts to secure a commission, I do not deny, for I have seen this done myself; but it is not fair to condemn an institution for the mistakes of a few of its representatives. It is certain that through the work of these agents many a man who never considered himself fit for advancement has been aroused to a realization of what he might be able to do if he only tried and has been assisted onward toward mental and financial betterment.

When it comes to catering to the ignorant for enrollment in correspondence schools the mechanical schools are "not in it." Thinking it might interest some of your readers I give the following extract from the matriculation blank of a college of ophthalmology and otology:

"Sign your name (print it if you cannot write it distinctly) in full. Do not give initials, but write what each initial stands for. Example: Not J. J. Jones, but John Jacob Jones."

To think of such a college attempting to coax into its ranks men who cannot write their own name distinctly is amusing if nothing else. The explanation about not writing J. J. Jones, but John Jacob Jones, would cause many of the kind of men who can scarcely write their own names to write John Jacob Jones no matter what their name might be.

That a school of ophthalmology and otology gets down that low bothers me some, but I certainly hope the mechanical schools will never deem it necessary to swell their ranks (and *rank* they would be) with men who have to print their own name because they cannot write it distinctly. It seems the worse because the instructions quoted are on their printed matter and must come from headquarters so that no poor hardworking agent can be made the scapegoat. Before quitting on this subject, I want to express my disapproval of the practice of correspondence schools of publishing a "key" volume in which all questions asked in the examination papers are answered and which is only too apparently done to save the expense of postage and time required to answer the students' questions, while at the same time it causes him to pick up the book for a solution to the problems rather than to use his brain for that purpose. CORNEIL RIDDERHOF.

Grand Rapids, Mich.

* * *

A ferryboat plying between Long Island City and New York was recently put out of commission for a day or so by a curious accident. A fireman had been ordered to clean a pump in the engine room, that was giving trouble. The cylinder head was removed and the fireman thrust his hand and forearm into the cylinder bore without difficulty, but when he tried to remove it the trouble began. The arm stuck fast and struggle as he might the unhappy man could not loosen it. He finally shouted for help, but when it arrived his arm had swollen so that the combined efforts of the engineer and deckhands could not pull him loose. A surgeon was sent for, not with the idea of amputating the offending arm but to reduce the swelling so that it could be pulled out. His efforts were unavailing and all he could do was to administer a hypodermic injection to reduce the pain. So tightly was the arm wedged that it was not considered safe to break the cylinder with a sledge, and it had to be sawn apart on one side and wedged open. It was six hours before the fireman was released.

ITEMS OF MECHANICAL INTEREST.

LARGE TOOL HOLDERS—ADJUSTABLE JAW WRENCH—SPRING DRIVING BELT A GERMAN SLOTTER—TURRET FOR HEAVY WORK—SLOW-BURNING CONSTRUCTION.

A "horrible example" of power distribution is to be found in a certain shop employing over 1,000 men. The power is furnished from thirteen boilers located at seven different points and fired by ten men, while the engines are of all sorts and descriptions, varying from old hoisting engines to plain slide-valve engines thirty or forty years old. There are better facilities in prospect, however.

A receipt for a pipe joint cement was given by Mr. Light at a recent meeting of the Ohio Gas Light Association, which is claimed to be as effective as red lead putty for either faced or rough flanged pipe joints and which costs only about one-tenth as much. It consists of a mixture of ordinary pine tar and iron oxide (fine borings or turnings well rusted will answer the purpose) mixed to a stiff paste. It does not harden so quickly as red lead putty and is very adhesive under pressure.

EFFICIENCY OF BOILER JOINTS.

The weakest part of a boiler shell is the longitudinal seam. This cannot, of course, be made as strong as the solid plate with any riveted construction, but a good design of joint employing multiple rows of rivets and cover plates, will closely approximate it. The Lukens Iron and Steel Company recently equipped their new power plant with horizontal tubular boilers having quadruple-riveted longitudinal seams. These are calculated to have not less than 94 per cent. of the strength of the solid plate. Samuel Vauclain, superintendent of the Baldwin Locomotive Works, has recently patented a design of boiler joint that has a calculated efficiency of 96 per cent. The weakening of the shell depends on how much of the material is cut away by the rivet holes; the smaller the holes the less it is weakened. This fact may make the use of nickel-steel rivets advisable in boiler construction where a high seam efficiency is necessary. The engineer of tests at the Bethlehem Steel Company has demonstrated that a nickel-steel rivet ¾-inch in diameter is as effective as a 1⅛-inch rivet made of common steel.

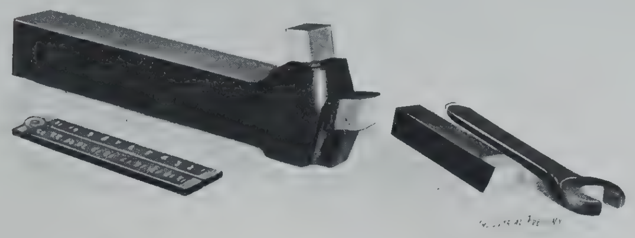
TESTS OF THE STRENGTH OF GLUE.

Bearing on the adhesiveness of glue an item has appeared in a contemporary, whose name we have lost, stating that it may be as much as 715 pounds per square inch. In an experiment performed a force of 1,260 pounds, applied gradually, was found necessary to separate two cylinders of dry ash wood, the ends of which presented a surface equal to 1.76 square inch, and which were glued together end to end and allowed 24 hours to set. Even this weight was sustained for two or three minutes before the joint gave way, and it was found, on examining the separated surfaces, that the glue was very thin and had not entirely covered the surface. The cohesive strength of glue appears, therefore, in this experiment to have been rather more than 715 pounds per square inch, while the cohesive strength of the wood in a lateral direction was found to be only 562 pounds, thus showing that if the joint had been between the sides instead of the ends of the pieces of wood, the wood would have given way before the glue. In this case, however, the glue was newly made and the season very dry, while in some former experiments made in the winter season with glue which had been frequently made, with occasional additions of glue and water, the cohesive force indicated was only 350 pounds to 500 pounds per square inch.

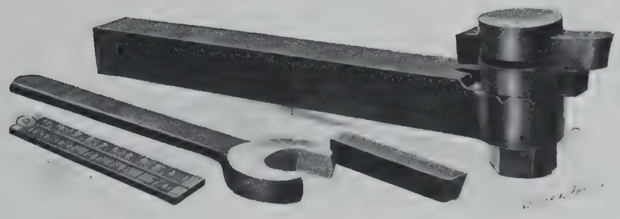
MAMMOTH LATHE AND PLANER TOOL HOLDERS.

While the use of inserted cutters, in lathe and planer tools, is a matter of every-day shop practice, probably few machinists are aware of the size of tools of this type that are practical and profitable.

The Western Mfg. Co., of Springfield, Ohio, sends us the photographs shown on the next page of large lathe and planer tools which they have furnished to many of the leading machine shops. The lathe tool holder is 3 inches square by 20 inches long and weighs 70 pounds. The planer tool holder is 3 inches square by 30 inches long and weighs 125 pounds.



Lathe Tool Holder.

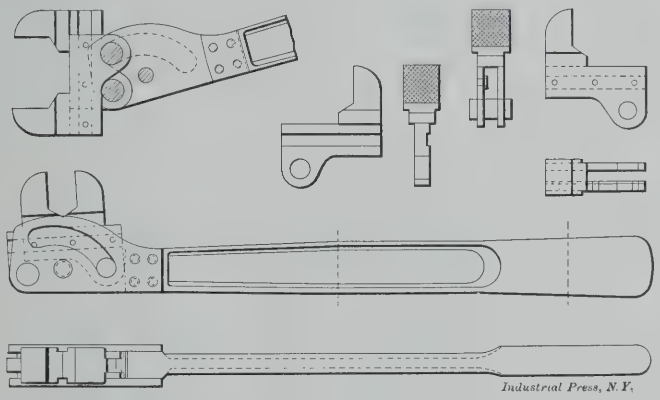


Planer Tool Holder.

Both holders carry self-hardening steel cutters 1½ inch square. These are without doubt the largest tools of the kind ever manufactured.

WRENCH HAVING ADJUSTABLE JAW.

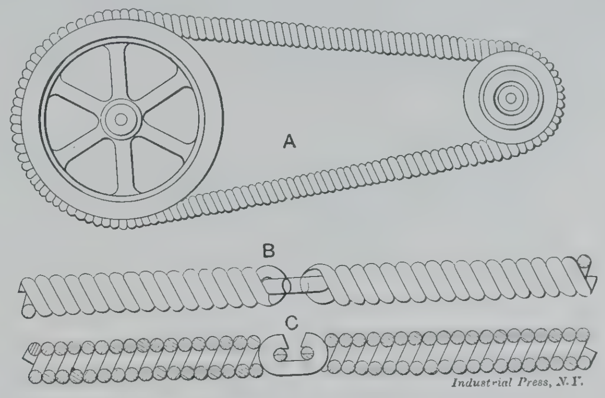
Many inventors have attempted to devise a sliding jaw adjustable wrench to supplant the ubiquitous monkey wrench, but their efforts have generally met with indifferent success. It is true that there are pipe wrenches of this type that are fairly successful, but they belong to a class of tools that apparently must be somewhat cumbersome to perform the work required of them. A sliding jaw wrench for bolts, other than the monkey wrench, that will compete successfully with the latter, is yet to be devised. A German effort in that direction is illustrated in the cut. The principle on which it works is so clearly shown that a long explanation is unnecessary. One advantage it has is that a nut or screw head is firmly gripped in one direction and promptly released when the handle is moved in the opposite way. This is all right within limits, but likely to be somewhat exasperating when one works in a constrained place where only one hand can be used to operate the wrench. Again, the angle at which the jaws stand relative to the handle, varies with the size of the nut. It is unnecessary to point out the nature of this defect to those who appreciate the advantage of the 15-degree angle jaws as found in drop-forged wrenches. There seems to be little likelihood that anything better can be devised for the machinist's use than a set of good case-hardened solid jaw drop-forged wrenches and his old friend and companion, the monkey wrench.



Adjustable Jaw Wrench.

COIL SPRING DRIVING BELT.

The use of steel wire coils for driving belts is something of a novelty—in this country at least. The illustration, Fig. 1, shows a German driving belt for light power that is made of wire closely coiled like a helical spring. In fact it is a spring, being made of tempered steel wire, and its elasticity is what makes it available as a power transmitter in place of leather or rubber belts. It is recommended by the maker, Gustave Pickhardt, Bonn a. Rh. for lathes, steam engine governors, sewing machines, tachometers, revolution counters, etc. Its use for lathes and other machine tools would, of course, be limited to those requiring little power such as bench, precision, watchmakers' and other foot-power lathes, sensitive drills, etc.



Spring Driving Belt.

SLOTTING MACHINE OF GERMAN DESIGN.

A slotting machine containing some interesting features and illustrated in Figs. 1, 2 and 3, is made by the Berliner Werkzeugmaschinenfabrik A.-G. formerly L. Sentker. The ram is screw driven and is not counterbalanced. The driving screw *N*, Fig. 3, has ball thrust bearings and is driven by bevel gears and a short intermediate shaft *M* from a transverse shaft on which are mounted the tight pulleys *A A'* and loose pulleys *B B'*, Fig. 2. The ram, of course, normally works in a vertical position, but it may also be operated in an angular position, as provision is made to shift it around an axis coinciding with that of the horizontal shaft *M*, about 30 degrees each side of the vertical line. A worm and section of wormwheel are provided for shifting it, and four clamping bolts for holding it in any position. The chief feature of interest aside from the driving mechanism is the method of ram reversal. The transverse driving shaft is continued through the column and is geared to the upper end of a vertical screw *Q*, Fig. 3, on which is mounted a nut *R*. This nut has the same length of traverse as the slide and moves in the same direction coincident with it. The points of reversal

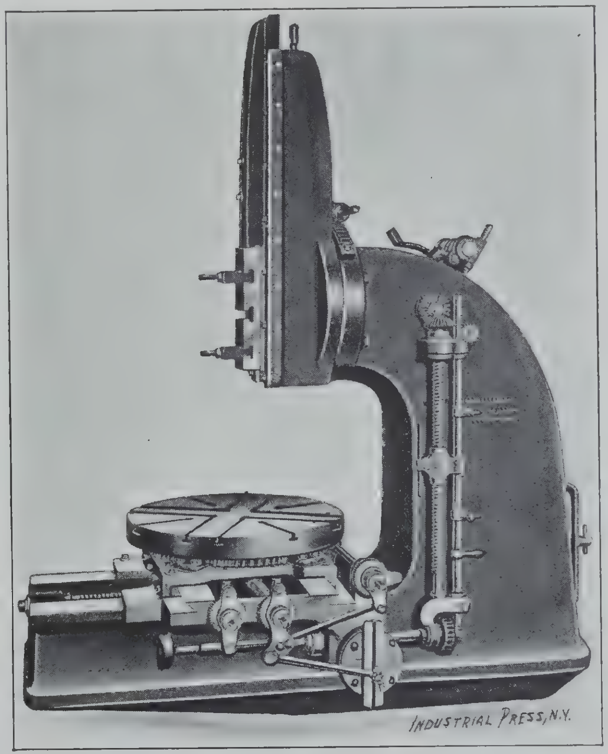


Fig. 1. A German Slotter.

are determined by the positions of the dogs or stops *S* which are clamped to the vertical shifter *F*. A handle is also fastened to the shifter for the convenience of the operator. Some other interesting details may be noted from the illustrations, which were taken from the *Zeitschrift des Vereines deutscher Ingenieure.*

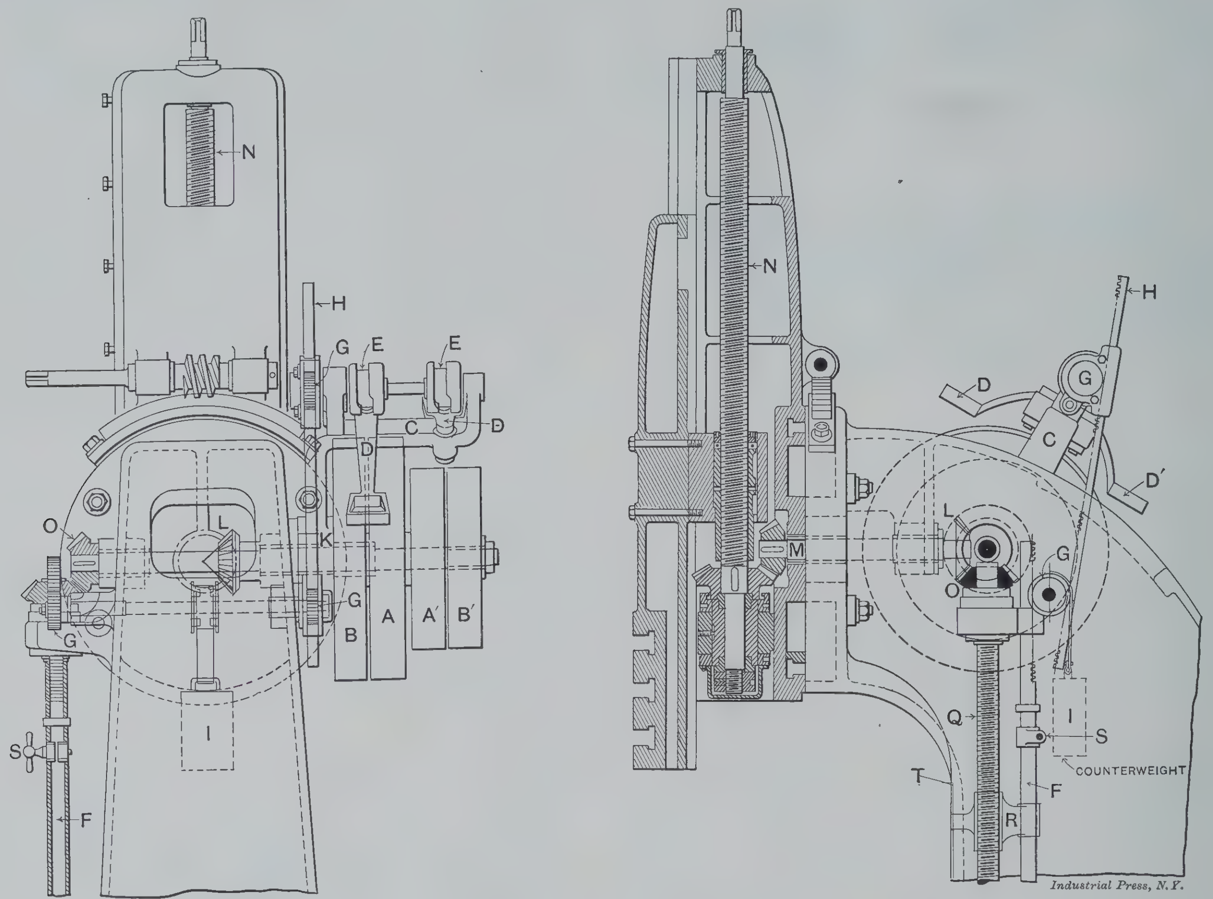


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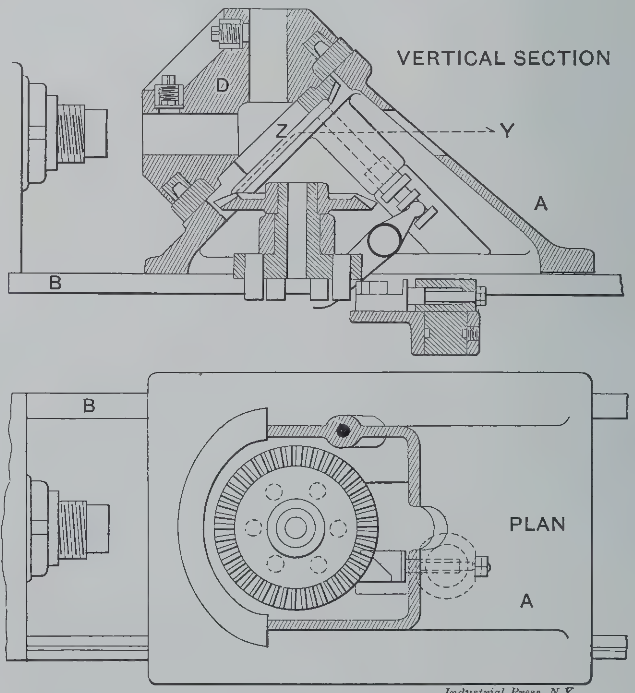
Fig. 2. Detail of Head of German Slotter. Fig. 3.

SLOW-BURNING CONSTRUCTION.

The "slow-burning construction," so frequently employed in the best factory buildings, has a wonderful capacity for resisting the ravages of fire. The heavy timbers which constitute the columns and floor beams, and the thick plank flooring, often stand up under the intense heat of a fire better than the so-called fireproof construction of structural steel, covered with non-conducting material. The heavy wooden timbers char, but do not burn through for a long time, while the steel members of the fireproof buildings warp and twist out of shape. Mr. J. A. Brown, superintendent of building inspection, Pittsburg, gives an example of a fire in a nine-story building of the slow-burning class. He says the building was packed with furniture from bottom to top and the goods in the three upper stories were practically burned up. On the seventh floor was stored a very large quantity of chair materials, packed from floor to ceiling. This material was all consumed, leaving on the floor ashes or charcoal from sixteen to eighteen inches in depth. The wooden beams or girders of the floor above the same, being 10 x 14 in size, were only partially destroyed; some of them burned half way through, none of them entirely. The fire in this story burned fiercely for about four hours.

TURRET CONSTRUCTION HAVING UNLIMITED CAPACITY FOR LONG WORK.

The ordinary turret cannot handle work quite as long as its diameter when all the holes are occupied by tools. A number of designs of turrets have been made to give unlimited capacity to the length of piece being worked regardless of whether all the tool holders in the turret are occupied or not. One form of construction used in the shop of an Eastern manufacturer of brass goods offsets the turret so that the center line of the lathe spindle passes by the side of the turret. The tools are fastened on its side and operate on the work as it passes by. Another design of recent date employs a ring turret that surrounds the lathe bed and rotates on a horizontal axis. The accompanying cuts show a recent German lathe design (Pittler) in which the turret is mounted so that its axis is inclined at an angle of 45 degrees to the spindle axis. The holes in the turret are inclined at the same angle to the base and so they are separated by an angle of 90 degrees, that is, opposite holes. The bevel gear ring by which the turret is turned, allows the work to pass through without interference; therefore, an indefinitely long piece may be turned or threaded. This construction is very similar to that of a tailstock turret made by the W. F. & John Barnes Co. for several years past. In this turret, however, the angle of inclination is 30 degrees and no provision is made for long work to pass through.



Industrial Press, N.Y.

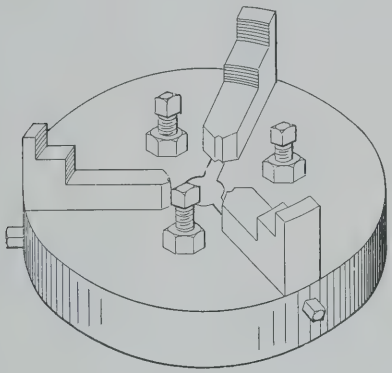
Turret for Long Work.

CONTRIBUTED NOTES AND SHOP KINKS.

TRUING WORK IN A CHUCK.

John Aspenleiter, Cincinnati, Ohio, sends us a kink for truing up work in a chuck when a number of disks, flanges or pieces of that nature are to be bored.

As all machinists know, a great deal of time is often wasted in getting the face of the work to run true in the chuck. To remedy this difficulty, three holes are tapped in the face of the chuck, between the jaws, and a setscrew with check nut provided for each hole. If the screws are set correctly for the first piece and then locked with the check nuts, all that is necessary for the following pieces is to butt them up against the screw heads and they will run all right.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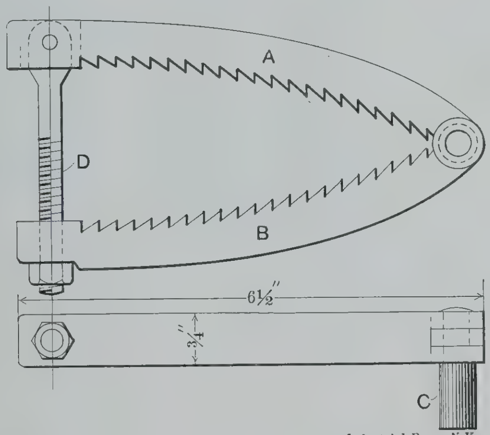
A "NEVER-SLIP" LATHE DOG.

Warren O. Rogers, Brockton, Mass., writes:

Some years ago, when I was employed as a machinist, among the petty annoyances that would occur was that caused by the slipping of the dog on round work, supported in the lathe centers. I had, however, never seen anything to obviate this difficulty until a few days ago, when I saw a dog that overcame the trouble in a very satisfactory manner. I think this may be of interest to some of the readers of MACHINERY.

As is shown in the sketch, the dog consists of two straps *A* and *B*, which are jointed at one end by a dovetail and pin *C*, while the opposite ends may be drawn together by the nut and screw *D*, thus gripping the work. The pin *C* projects from one side and is used for driving the work. A dog of the dimensions given is suitable to use with work from ¼ inch to 2 inches in diameter.



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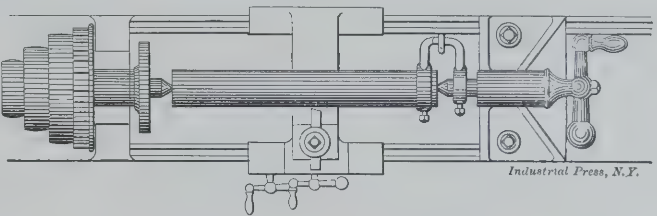
Lathe Dog.

With this dog, if the work has a tendency to slip, it simply forces itself toward the apex formed by the jaws and thus increases the grip of the dog on the work.

CUTTING KEYWAYS IN A LATHE.

John Aspenleiter, Cincinnati, Ohio, says that in a small shop where there is no shaper, or where the shaper is in use, and it is necessary to cut a small keyway in a shaft, the job can be done in a lathe in a quicker and more satisfactory manner than by chipping and filing. Put the shaft on the centers, as shown in the sketch. Place a lathe dog on the end of the shaft toward the tailstock and another on the tailstock spindle. Clamp the tails of the two dogs together, thus preventing the shaft from turning, yet leaving the live center free. Now put the tool in the tool post with the cutting edge facing the headstock. Gear up the lathe to give the proper cutting speed and use the leadscrew to drive the carriage the same as when chasing a thread. At the end of each cut pull out the tool by the cross feed screw and return the carriage for another cut.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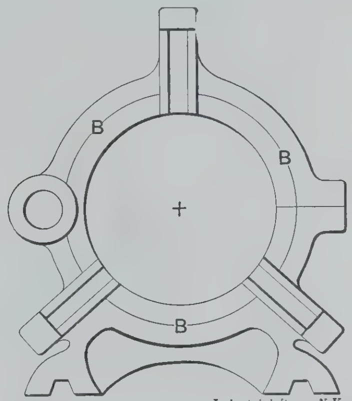
Lathe Arranged for Cutting Keyway.

If the keyway is very short, the carriage can be fed by hand, but for cutting a keyway of any length it is preferable to use the leadscrew.

CENTERING WORK IN STEADY REST.

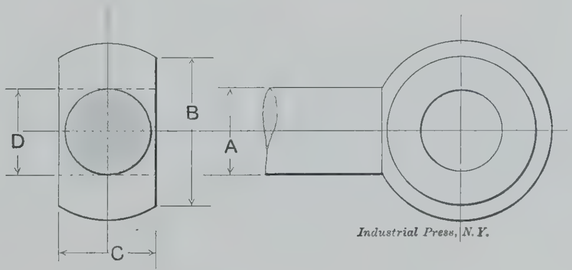
J. W. S. sends a "kink" for ascertaining if work is central when placed in the steady-rest. He first removes the jaws and then with a tracing tool, held in chuck or fastened to the faceplate, he describes the circle *B B* on the body of the rest. The work is then easily centered by measuring to this circle.



Industrial Press, N.Y.

PROPORTIONS OF LINK ENDS.

Robert S. Brown sends a sketch of a steel link end which has proved very satisfactory for use on automatic machinery, engine link motions, etc.; as it gives a finished appearance without costing too much to manufacture. The spherical end may be turned in any lathe which has a swivel tool carriage; or an attachment for turning hand wheel rims, in which the tool point is moved in a circular path, will answer.



Industrial Press, N.Y.

The dimensions are:

$A =$ diameter of link at body.
$B = 1\frac{1}{2} D + \frac{1}{8}$ inch.
$C = A + 1\text{-}16$ inch.
$D = A$.

The flat spot *B* will be seen to give as much bearing as is found between flats on a standard hexagon nut of the nominal size of *D*.

NEW TOOLS OF THE MONTH.

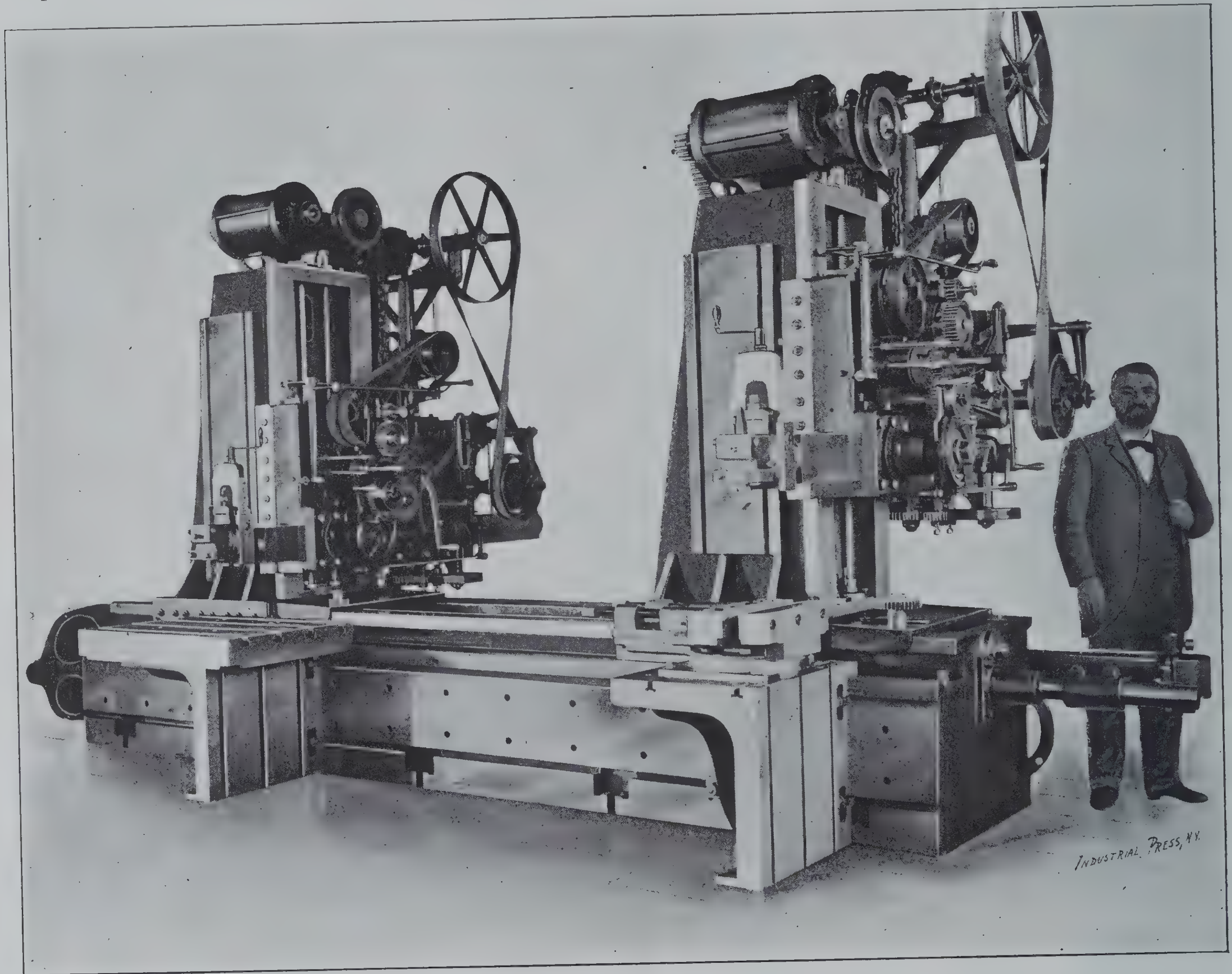
A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

DUPLEX TRAVELING HEAD SHAPER.

The traveling head shaper shown in the engraving has been brought out by the Morton Manufacturing Co., of Muskegon Heights, Mich., and embodies several new and useful features. The shaper is electrically driven and operates on the "draw cut" principle.

This machine has 36-inch stroke, 30-inch vertical feed on the column, and the length of the bed is 14 feet. It is built either single or double-headed and furnished with one or two tables as the case may require. When it is desired, the tables may be constructed to raise and lower for purposes of adjustment.

The machine has automatic feeds in both directions and is also provided with means whereby the aprons and columns may be moved by power, either vertically or horizontally when adjusting them to the work. The movement of the column on the bed is obtained by a screw which remains stationary, the nut revolving. The apron of the shaper is gibbed and fitted to the vertical column, and the vertical adjusting screw is also stationary, being operated with a revolving nut. These revolving nuts are fitted with ball-bearing thrust collars.



Duplex Traveling Head Shaper.

The ram is square and has a bearing on all four sides, wear being taken up with taper gibs. The stroke is adjusted by tappets on a circular disk and a suitable lever is provided whereby it may be reversed at any part of the stroke. The reciprocatory motion of the ram is obtained by two friction clutches, one being operated by an open belt and the other by a cross belt. It has a quick return stroke of three to one.

The countershaft is provided with a friction clutch and is stopped and started instantly at any part of the stroke by means of a lever provided for this purpose, which brings the machine under complete control of the operator.

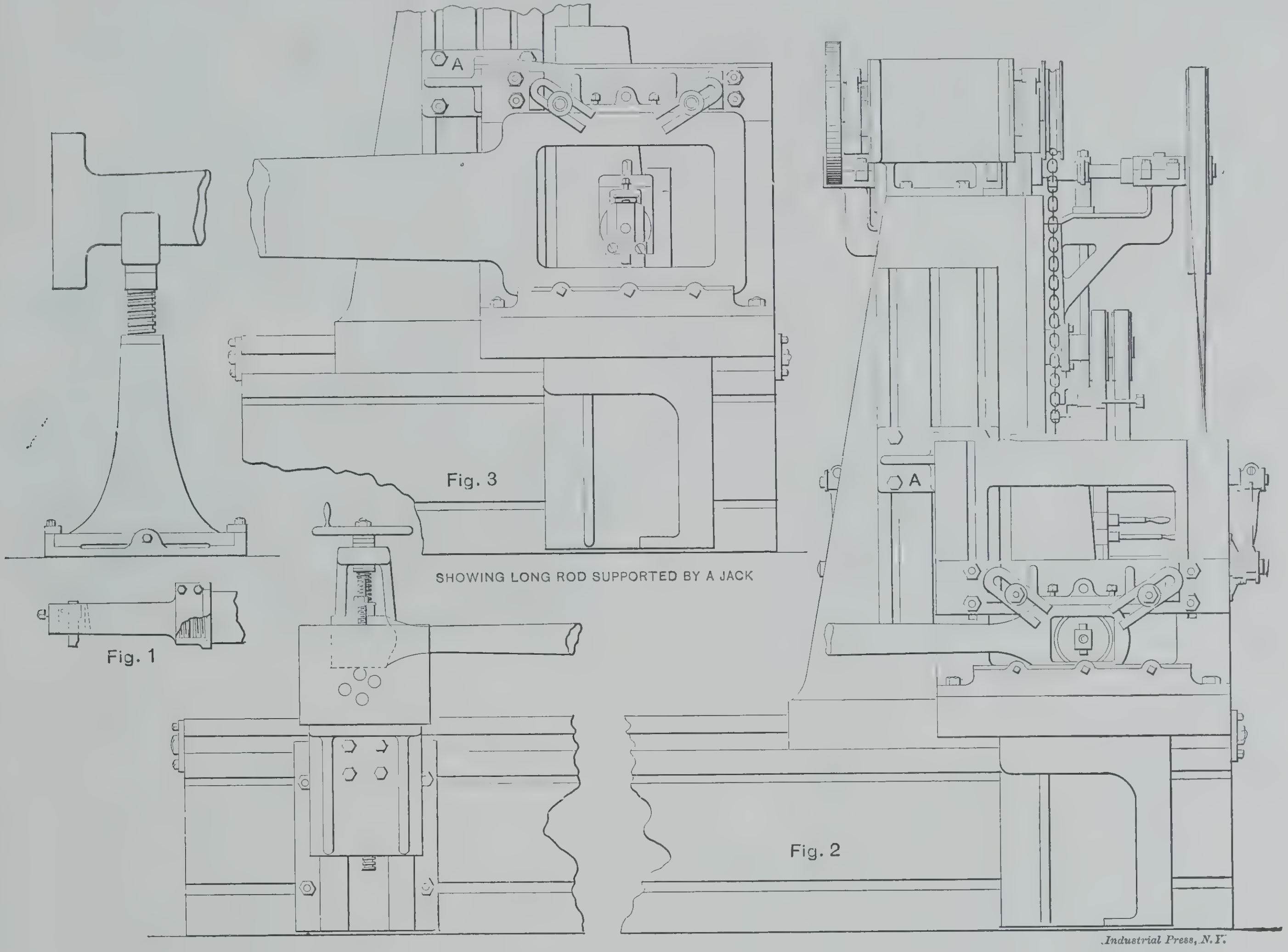
The friction feed is of the automatic relieving type and is positive in its movements.

The aprons are counterbalanced by a special coil spring arrangement inclosed in the cylindrical casing at the top of the column. The rail bearings on all portions of the machine are square and the gibs employed are of the taper type.

One commendable feature of this shaper in which it differs from any other that has ever been produced before, is that of the vertical feed on the column, which enables the machine to take vertical side cuts and makes it well adapted for internal work. The head may be removed and a special head, shown in Fig. 1, secured to the end of the ram so that internal slotting may be accomplished with this tool. Each head is driven independently, so that either one may be brought into action and operated entirely independent of the other. Both heads obtain their feeding power with revolving nuts from the same screw.

A particular advantage with this style of shaper is that one head can be operated on a piece of work 30 inches above the table, while the other head may be operated at any intermediate point.

The illustrations, Figs. 2 and 3 on the next page, show this shaper machining an opening in a solid end connecting rod. It will be noticed that a suitable adjustable chuck is provided for holding the end of the rod to be ma-



Traveling Head Shaper Operating on a Connecting Rod.

chined, and a support *A* is placed between the top of this chuck and the column of the shaper. This allows the machine to be fed vertically or horizontally. When machining the opening, a cut may be taken across the bottom, then the head turned ninety degrees and a cut taken up the side; it can then be changed and a cut taken across the top and another change made and a cut taken down the end. This enables the opening of a connecting rod to be planed out on all four sides, the rod remaining in a stationary position.

As will be seen in Fig. 2, the outer end of the rod is supported in a suitable chuck placed on the second table of the machine. When but one table is furnished an adjustable jack, shown in Fig. 3, is used for this purpose.

It will be seen that with the automatic feeds on the column and the range which the shaper has, a great deal of irregular work may be accomplished which has heretofore been difficult to reach with any tool.

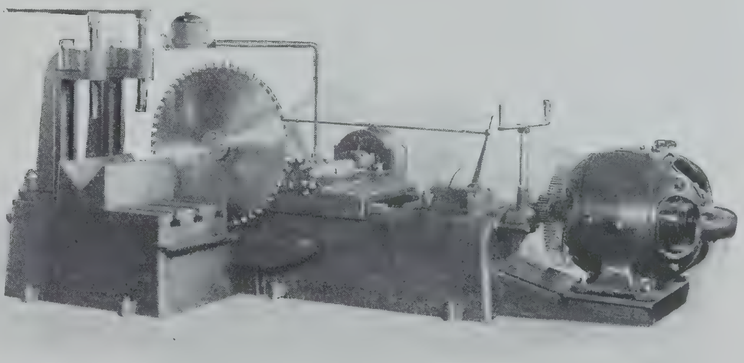
It may also be used in the capacity of a portable shaper, as with the vertical adjustments on the column, it is adapted to be used in connection with a floor plate, in planing off spots on large castings, pillow blocks for medium-sized Corliss engine frames, etc. The plate on the front side of the column is planed so that a suitable bearing may be placed in between the work and the frame of the machine, thereby putting the thrust of the cut directly against the column.

This shaper is very heavily geared and capable of taking a cut of 1¼ inch deep in steel, with 1-16 inch feed.

NEW LINE OF COLD SAWS.

The Q. & C. Co., Chicago, Ill., have recently brought out a line of metal cutting machines embodying several improvements over those formerly built by them. They manufacture two types of these machines—"Bryant" saws, in which the saw blade is driven by a gear or sprocket wheel engaging with the teeth formed on the periphery of the blade, and arbor-driven saws, on which the saw blade is driven by a central mandrel or arbor. Both types are made either as cut-off saws, having a short travel and especially suited for cutting bars and structural shapes; or as universal saws in which the travel of the blade is longer and the machine is fitted with an upper side table on which the work can be cut off for the entire length of the travel of the saw blade, while they are also arranged with V-blocks and lower tables for cutting bars and shapes.

The illustration shows one of the Bryant type of saws operated by an electric motor. They are also manufactured for belt driving. Any machine can, when desired, be mounted on a circular base, which can be completely rotated by rack and pinion, this being a very desirable feature where there is not sufficient room for swinging a long beam. Lateral adjustment of side tables can be furnished, if required, so that work can be adjusted for cutting after being secured.



Bryant Cold Saw made by the Q. & C. Co.

The tables, on all machines, have been so arranged that work can be placed most advantageously for cutting with minimum distance of blade travel, the longer slide tables being of sufficient length to properly support beams when being cut off at any angle up to 45 degrees.

All machines are fitted with friction feed, giving an automatic feed, variable with the machine in motion, from ¼ inch to 1 inch per minute on the Bryant saw and from 3-16 to 13-16 inch per minute on the arbor-driven saws.

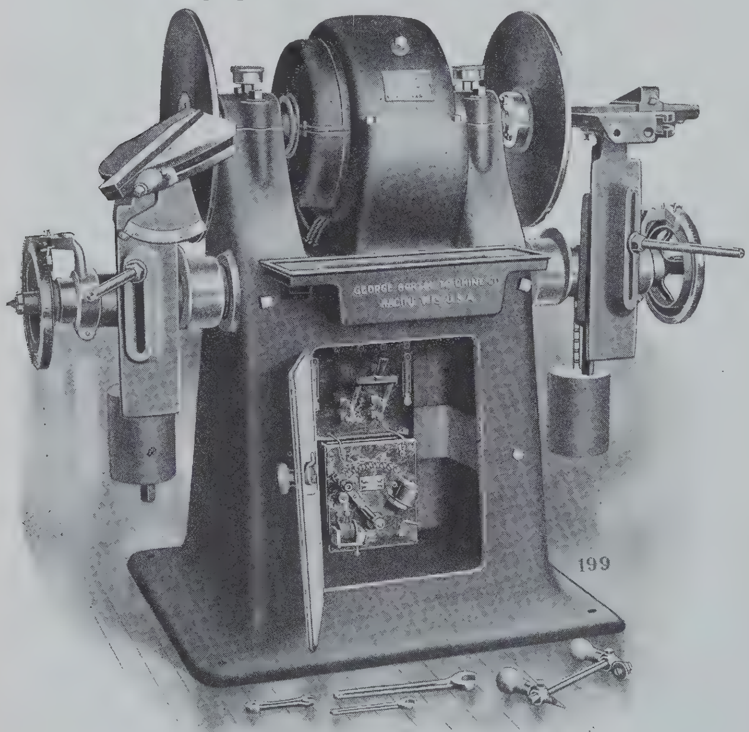
The universal type of machines is fitted with a power return movement.

The "Bryant" saw carriage is in two parts, the sprocket shaft bearing being cast in one piece with the worm gear hood, and movable 2½ inches toward the axis of the blade, allowing for a wear of 5 inches in its diameter. The sprocket is removable, and all sprockets on these saws are interchangeable and readily replaced.

All gears, in both types, are entirely inclosed, thereby avoiding dust and lessening liability to accident.

ELECTRICALLY-DRIVEN DISK GRINDER.

The George Gorton Machine Co., Racine, Wis., have designed their No. 6 B disk grinder for electric driving. The machine has a pedestal cast in one piece, heavily ribbed, internally, and is provided with a dust-proof, automatically ventilated, 5 horse power compound-wound motor. The arbor is of hard tool steel and the armature is mounted upon a conical bearing upon the arbor so that it may readily be removed without driving. The machine is dust-proof throughout and particular attention has been given to the matter of lubrication. The tool is provided with the company's standard feed works upon each table. The handwheels register in thousandths of an inch and are provided with adjustable stop. The left-hand table is adjustable in degrees to the face of the disk and both tables are provided with protractors reading in degrees, which are quickly detached when desired. Each table may be adjusted vertically and is balanced, and is automatically maintained in swinging balance regardless of vertical adjustment.



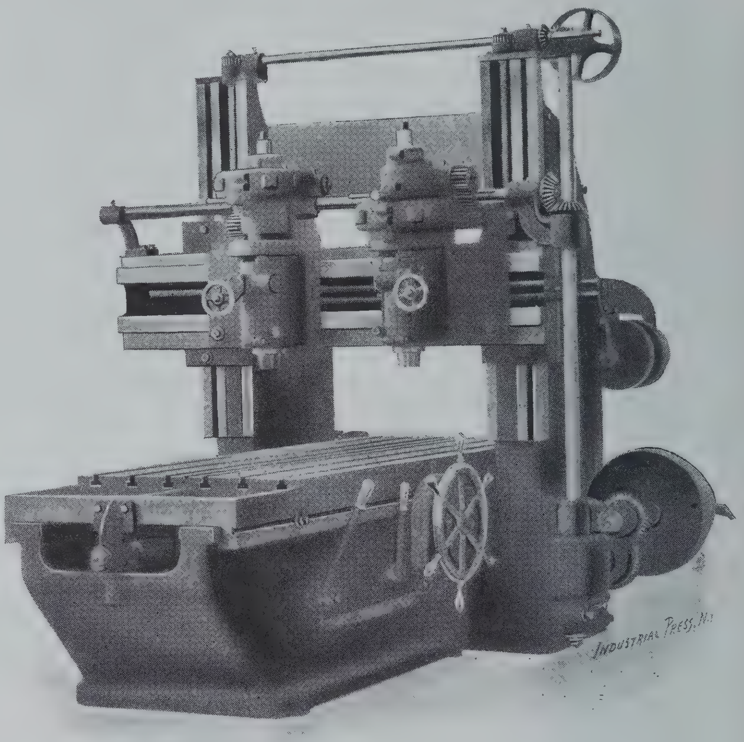
Electrically-driven Disk Grinder.

Each machine has four 18-inch steel disks, accurately finished, a cementing press for the same being provided, with positive means for raising the steel disk from the lower press flange. A water pan is furnished, with a shelf at the rear having a pocket for wrenches, which are also provided. The net weight of the machine is 2,100 pounds.

NEW DOUBLE SPINDLE MILLING MACHINE.

The Beaman & Smith Co., Providence, R. I., have brought out a milling machine having two vertical spindles, illustrated herewith. It consists of a substantial bed on which is mounted a table, and to which uprights supporting the cross rail for the milling heads are firmly attached. The features of the machine are clearly shown in the illustration and it will not be necessary to do more than give the general specifications.

The table is 36 inches wide, 8 feet long, and in addition to the usual feeds by means of a screw, it is provided with quick power movement in either direction. On the cross rail are the heads carrying spindles, which are provided with horizontal adjustment by means of screws.

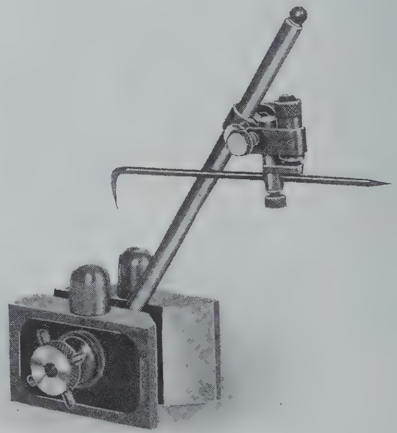


Beaman & Smith Double Spindle Milling Machine.

The spindles are driven by a 3-inch belt on a four-section cone through gearing in the ratios of 4½, 10, 19 and 40 to 1, providing spindle speeds from 6 to 91 revolutions per minute in either direction. They are also provided with independent vertical adjustment of 3 inches.

A NEW SURFACE GAGE.

The Sawyer Tool Mfg. Co., of Fitchburg, Mass., have brought out a new surface gage provided with micrometer adjustment. The sides of the base are ground parallel and true and upon the upper surface are two bosses for use in planer bed slots or similar positions. The base is slotted so that the spindle can be revolved through three-quarters of a circle, thus giving a wide range of adjustment. The clamp upon the spindle holds a block which can be swung either up or down to any desired angle and clamped solidly in position. A knurled thumb screw, on the under side of this block, holds the needle or scriber in position; while a knurled head, on the



Improved Surface Gage.

upper side, gives the needle an up-and-down parallel motion. This motion will be appreciated as a very desirable feature of the gage. The knurled head in front clamps the needle rigidly when the adjustment has been made.

THE BATH AUTOMATIC, UNIVERSAL COMBINATION GRINDER.

Figs. 1 and 2 show a new design of an automatic universal combination grinder, which is being manufactured by the Loop-Lock Machine Co., of Waltham, Mass., successors to the American Watch Tool Co., under the direction of the inventor, Mr. John Bath. The machine is being placed on the market by Messrs. Hill, Clarke & Co , of Boston, New York, and Chicago.

Fig. 1 shows the machine arranged for cylindrical grinding. The wheel is guarded by an adjustable band and provision is made for the use of water.

The knee and frame of the machine are so constructed that all water returns by the trough, shown around the base of machine, to the tank. This attachment is so constructed that it takes away all the water, producing no slop around the machine.

The wheel head is carried by a vertical arm, the top portion of which is threaded, and is moved up and down by a combined hand wheel, nut and dust cap. This is provided with a micrometer adjustment. The head is also gibbed to a vertical slide which provides rigidity in any position.

The swivel plate has two slots which permit of the headstock, footstock or attachments being removed without any interference with the head of the clamping screw which preserves the set alignment of the swivel plate. The two slots are also useful in clamping work for surface grinding.

Fig. 2 shows the knee swung around the column in position for surface work, and also the new automatic longitudinal feed. The feed is driven from a drum above, in the countershaft, to a cone pulley at the side of the knee. When in use for cylindrical work the belt runs on large step of cone, and for surface work on small step, which gives the higher speed required for surface work.

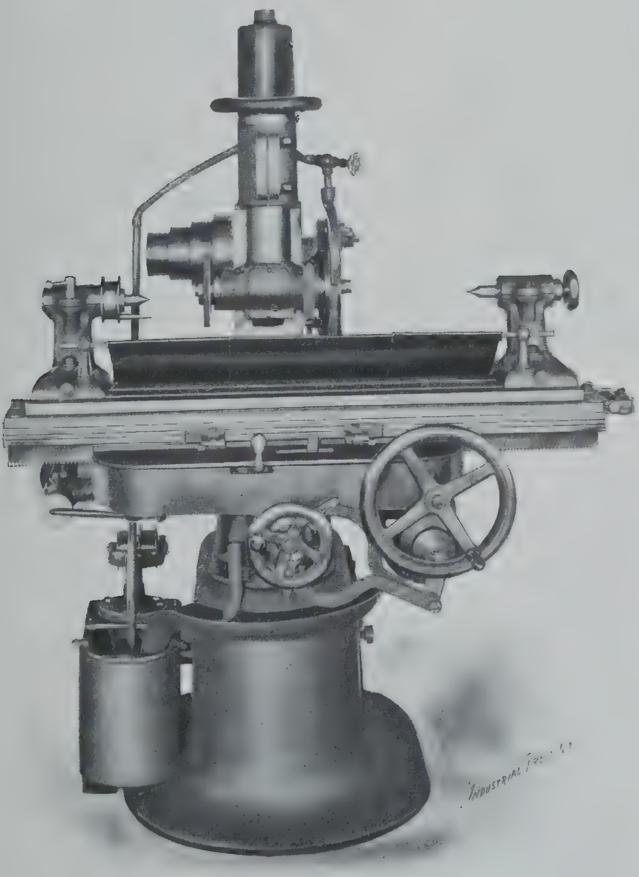


Fig. 1. Bath Grinder arranged for Circular Grinding.

The power cross-feed attachment for surface work is also shown. It is so constructed that either one or two pawls may be engaged at the same time, and adjusted to give a fine or coarse feed. The feed may be quickly disengaged by the knurled knob back of the large hand wheel.

At the front of the bottom slide is an enclosed box apron having a removable top cover, so that all the inside workings of the feed are accessible for inspection or adjustment.

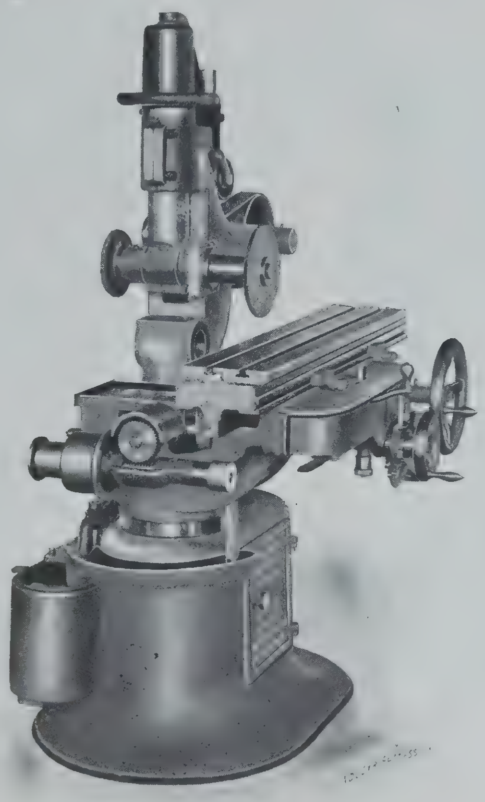


Fig. 2. Bath Grinder arranged for Surface Grinding.

In addition to its use for cylindrical and surface grinding, the machine is provided with numerous attachments that fit it for internal grinding and for grinding all kinds of milling cutters, reamers, twist drills, and lathe tools.

NEW HYDRAULIC PRESSES.

Figs. 1 and 2 on page 116 show two new hydraulic presses designed by Mr. Chas. F. Burroughs, which are being built and sold by the Charles F. Burroughs Company, of Newark, N. J.

These presses were originally intended for jewelers' use, for die sinking and similar purposes, but they are not confined to this field as they may be adapted to almost any purpose where hydraulic machinery is required.

The press consists of but three principal parts, the cylinder, plunger and platen; and the entire press rests upon a substantial base which contains the water used for raising the ram.

The cylinder may be copper lined or not, as the duty may require. A particular feature of the presses is that the cylinder, rods and head are all in one piece.

The smaller press, shown in Fig. 1, is arranged to be operated by the hand pump shown on the side. This pump contains an external and internal piston. The external piston is used to give a large quantity of water at a low pressure, after which it is securely locked down by means of the small handle, shown under the main lever, and at the same time the smaller internal piston is released, thereby enabling the operator to obtain the required high pressure.

Fig. 2 shows a press constructed after the manner of the smaller one, but with the pump arranged to be operated by power. This pump consists of an internal and external piston the same as the hand pump, except that the larger piston is actuated by the springs shown under the pump. These springs are sufficiently powerful to raise the press ram and give low pressure per square inch, after which they remain extended with the large pump piston at its upper stroke. The small internal piston continues to work, giving the required high pressure.

The power pump may be attached to the smaller press if it is desired.

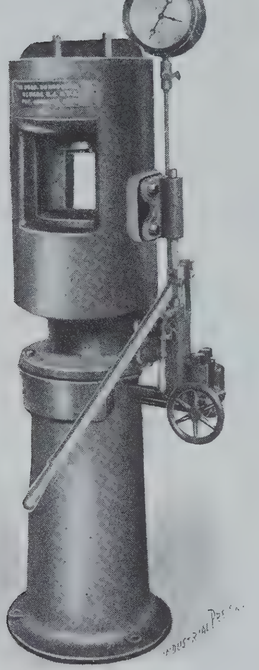


Fig. 1. Hand Hydraulic Press.

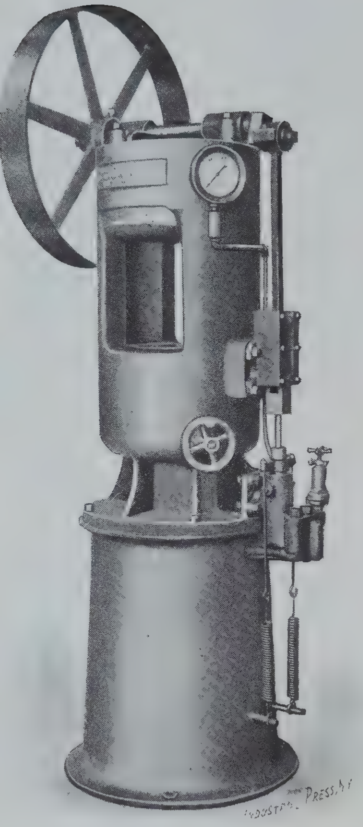
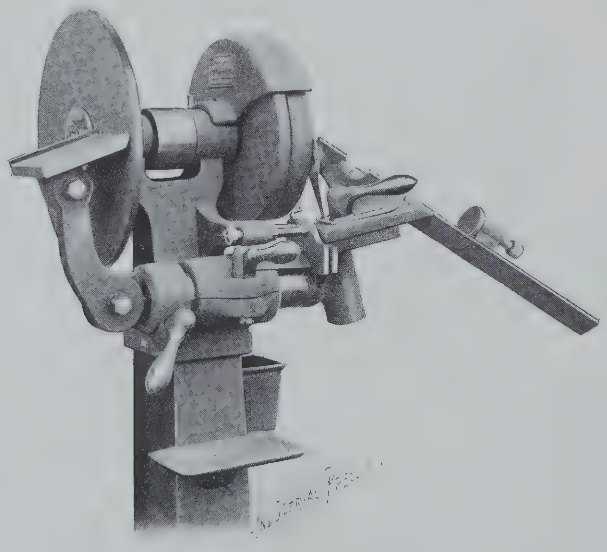


Fig. 2. Power Hydraulic Press.

The small press has a capacity of 300 tons and weighs but 1,275 pounds; the larger press has a capacity of 500 tons and weighs 2,300 pounds. The floor space required for the small press is 1½ by 1½ feet and for the larger 2¼ by 2¼ feet.

DISK GRINDING ATTACHMENT FOR TWIST DRILL GRINDER.

L. S. Heald & Son, of Barre, Mass., have brought out an attachment for their twist drill grinder in the shape of a disk grinding attachment which is substituted for the thinning attachment frequently sent out on these machines. This disk grinding attachment consists of a large plate about 12 inches diameter, together with a suitable table which can be tipped to make any angle with the face of the wheel and oscillates on the end of the sleeve, back and forth on the wheel face; or it may be clamped rigidly in any particular position.



Disk Grinding Attachment.

This attachment is designed for grinding and polishing in those shops where the amount of work is not of sufficient quantity to warrant the installation of a regular disk grinding machine.

This fixture is capable of being attached to any of their twist drill grinders now in use.

COLD SAW CUTTING-OFF MACHINES.

A new line of cold saw cutting-off machines is being built by the Espen-Lucas Machine Works, of Philadelphia, after the design of Mr. W. H. Lucas. These machines are being built for cutting bar steel and I beams, and there are three sizes of each pattern. The clamp is swiveled so that it can be quickly adjusted to odd shapes or for cutting on angles. Saw blades 3-16 inch in thickness and 22 inches in diameter are used. The feed is automatic, with automatic safety stops controlling the depth of cut, and is variable from ¼ inch to 1½ inch per minute. The lubrication of the saw is provided for by an oil box in which it constantly revolves.

* * *

ADVERTISING LITERATURE.

The Franklin Machine Works, Philadelphia, Pa. Illustrated catalogue of horizontal floor boring, milling and drilling machines. Also of cold-saw cutting-off machinery and of plain milling machines.

Schumacher & Boye, Cincinnati, O. Special circular descriptive of their 36 and 42-inch triple-geared and back-geared engine lathes. The circular contains a number of fine illustrations of these lathes and a full description of same.

The Standard Tool Co., Athol, Mass. 1902 catalogue of mechanics' fine tools. These include surface gages, steel squares, try-squares, depth gages, bevel protractors, straightedges, calipers, dividers, etc.

The Bradford Machine Tool Co., Cincinnati, O. Circular of their 16-inch engine lathe, containing a full description of this lathe and a cut of same. The lathe is also made in 14, 18, 21, 25, 28 and 32-inch sizes.

The Northern Electrical Mfg. Co., Madison, Wis. Bulletin No. 29 of the "Northern" multipolar motors. The motors and their various parts are fully described and illustrated, and the booklet shows in a very complete manner the variety of "Northern" apparatus.

The New Haven Mfg. Co., New Haven, Conn. Catalogue A of iron-working machine tools, including iron planers, from 20 to 60 inches wide; engine lathes, from 18 to 65 inches' swing, and drilling machines, 28 to 40 inches' swing. The catalogue is handsomely illustrated.

Wyman & Gordon, Worcester, Mass. Pamphlet giving a short account of the life of Sir Henry Bessemer, of Bessemer steel fame, and calling attention to the steel forgings manufactured by the company. These are made by drop hammer, steam hammer and hydraulic press.

The Lunkenheimer Co. Cincinnati, O. Illustrated catalogue and price list of brass and iron valves, injectors, whistles, lubricators and steam specialties. This catalogue contains 208 pages, is fully illustrated and will prove valuable to prospective purchasers of such specialties. The catalogue can be procured gratis by addressing the company.

The Garvin Machine Co., New York. Catalogues Nos. 10, 12 and 14 of the series issued by this company. No. 10 treats of their screw machine tools and attachments; No. 12, of duplex drill lathes, hand lathes, slide rests and spring coilers; and No. 14, of their special machinery. No. 14 also contains a general index of the company's products.

The Hayden & Derby Mfg. Co., 85-89 Liberty St., New York. Illustrated catalogue of the "Metropolitan" automatic injectors, Metropolitan 1898 injectors, and Metropolitan double tube injectors manufactured by this company. Also of the H. D. ejectors and of other jet apparatus. The catalogue contains, besides, much useful information relative to injectors and ejectors, and will be sent to anyone interested.

The Worcester Emery Wheel Co. Worcester, Mass. Circular of the emery and corundum wheels, for fine and rough work, manufactured by this company. Silicate or semi-vitrified wheels, and thin elastic wheels for light grinding or for the grinding of thin, hard stock are also made; and the company also take orders for wheels for special work. A table of grades of emery for various kinds of work and one of the different speeds of emery wheels are given in the circular.

MANUFACTURERS' NOTES.

The Automatic Machine Co., Greenfield, Mass., manufacturers of machine tools, are building a new shop 120 feet square, with a wing 35 x 40 feet. They expect to move in about October 1.

The Baush Machine Tool Co., Springfield, Mass., manufacturers of multiple spindle and radial drills, etc., are adding to their foundry a storeroom and a room for tumbling barrels 30 x 75, 17 feet high.

The Joseph Dixon Crucible Co., Jersey City, N. J., have gotten out an ingenious color chart for so displaying the colors of Dixon's silica-graphite paint as to give an exact idea of each color. The chart also contains instructions for applying the protective paint.

The Whiton Machine Co., New London, Conn., manufacturers of the Whiton revolving centering machine, are building a foundry 66 x 127 feet, and an adition to their machine shop 35 x 80 and 50 x 54 feet, three stories high.

In the advertisement of the Wm. E. Gang Co.'s improved radial drill in our September number, page 33, an error appears in the first paragraph. Instead of reading "The arm is of *one* section, well ribbed," it should have been "The arm is of *box* section, well ribbed."

The Cling-Surface Mfg. Co., Buffalo, N. Y., send us a copy of a letter received by them from the Dominion Motor and Machine Co., of Toronto, expressing their satisfaction with Cling-Surface, and stating that by its use they save from 5 to 10 per cent on their horse power.

The Loop-Lock Machine Co., of Boston, have acquired the plant, business and good-will of the American Watch Tool Co., Waltham, Mass. The manufacture of precision machinery, compound punches and dies, watchmakers' lathes and attachments will be continued by the Loop-Lock company, to whom all checks are now payable. The president of the new corporation is H. N. Fisher; the treasurer, S. A. Barton.

The Hampden Corundum Wheel Co., Springfield, Mass., whose works were destroyed by fire some months ago, now have their new plant in full operation. The buildings are all of brick, of modern construction, and both the office and works are thoroughly equipped throughout. The main building is 80 x 136, four stories and connected with it by bridges are the office and storeroom 50 x 120. The kilns are of the latest design, of two and one-half times the former capacity, and they effect a great saving in fuel over the old ones.

The Bradley Co., Syracuse, N. Y., manufacturers of upright hammers, have commenced work on a new machine shop 80 x 260, one

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story high; a forging room 50 x 100, and a building for office, pattern and drafting room 50 x 80, which they expect to have ready for occupancy next August. The new plant will be located on a three-acre plot of ground which they recently purchased near the West Shore Station and within a stone's throw of the center of the city of Syracuse.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., have made arrangements with the Armour Institute of Technology whereby the Institute will co-operate with the American School in the instruction of their students by correspondence. The American School is located on the Armour Institute premises at Chicago, but remains a separate institution under its own management. The students' examination credits will be counted toward a degree at the Armour Institute, and they will be admitted to classes at the Institute in the subjects in which they have passed by correspondence.

THE STANDARD ROLLER BEARING CO., Philadelphia, Pa., are building shops on a three-acre plot of ground at the corner of 48th Street and Girard Avenue, facing the P. R. R. One building will be 200 feet long and 150 wide, and the other principal building will be 200 feet long and 60 feet wide, three stories high. These buildings, with those already on the property, will give a total floor space of about 80,000 square feet. The new shops will be equipped with the latest and best machinery for the manufacture of ball and roller bearings, and will include a department for the manufacture of balls. The superintendent of the ball department will be Robert H. Grant, formerly of the Grant Ball Company. The plant will be ready for operation about November 1st, when it is expected that about 300 men will be employed.

THE FITCHBURG MACHINE WORKS, Fitchburg, Mass., under the management of Mr. F. B. Manville, formerly of Waterbury, Conn., have taken on a new lease of prosperity and are now running twenty-three hours a day, with orders for several months ahead. The plant is being thoroughly overhauled, new tools are being put in where needed and the works brought up to date. A Gisholt lathe has been ordered, and a universal grinding machine and a large vertical milling machine of the planer type will soon be bought. Manning, Maxwell & Moore handle the entire output of traveling head shapers, horizontal boring mills and countersinking drills for boilermakers. J. J. McCabe and the Marshall & Huschart Machinery Co., in combination, sell the entire output of their 14-inch to 60-inch lathes. The manufacture of planers has been discontinued.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line.

The money should be sent with the order.

AGENCY WANTED for high-class engineers' and woodworkers' tools by thorough engineer with own workshop. Power in showroom. Good connections in England. Established in 1876. W. ROBERTSON, Engineer, Eccles, near Manchester, England.

FOR SALE CHEAP.—Two colored charts, A. and B., for scientific tool tempering, explaining tempering in oil, water and tallow, and telling what each tool will stand. Also, 40 new steel working methods for forging and welding different kinds of steel and five of the best steel welding compound receipts on earth. All new and up-to-date. Send for free samples. The two charts and the 40 new methods for $1.00. Address W. M. TOY, Sidney, O.

FOR SALE.—The first six volumes of MACHINERY. Address G. H. G., care of MACHINERY, 15 Murray Street, New York City.

INVENTOR'S MODELS built and perfected, special machinery designed and built, small parts duplicated. Let us quote prices. F. J. STOKES MACHINE CO., Philadelphia, Pa.; New York representative, FRANK P. WISNER, 46 Cliff St.

MANHATTAN TYPEWRITER FOR SALE—Same size and keyboard as Remington No. 2. Used about two years and in good running order. Price $25. Address INDUSTRIAL PRESS, 15 Murray St., New York.

MECHANICAL ENGINEER, 24 years old, energetic, ambitious, technical graduate, 5 years' experience in shop and drawing room, good constructor and draftsman, desires to make a change December 1 or earlier, and is looking for a good position with chances of advancement with concern in or near New York City. Address GRADUATE, care of MACHINERY, 9-15 Murray St., New York.

SPECIAL TOOLS, models, fine light machinery and foundry work wanted. MURRAY MFG. CO., Richmond Valley, Staten Island, N. Y.

SWEDISH-AMERICAN FOREMAN.—Wanted, several first-class Swedish-speaking machine shop foremen, well up to date, in modern shop practice. Apply in Swedish, stating age, experience and wages expected. Address AKTIEBOLAGET SEPARATOR, Stockholm, Sweden.

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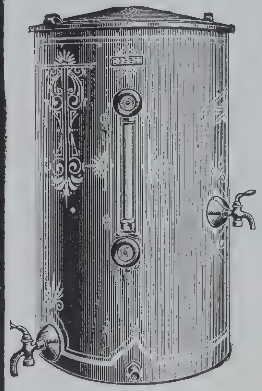
WANTED, in the publication department of a large machinery manufacturing concern in New England, a young man to prepare all literary matter, edit a monthly engineering magazine, supervise all illustrative work and conduct the advertising. Much be technically trained, a master of good English, and experienced in the work above outlined. A permanent, growing position for the right man. State experience, submit samples of work and specify salary expected. Address PERMANENT, care of MACHINERY, 9-15 Murray St., New York.

WANTED.—Foreman polisher by a medium heavy machine tool concern employing 250 men; located 150 miles from Chicago. Splendid shop in city of 25,000 people. A man who is a good hard worker; who can take charge and can also keep busy himself. Only a married man of ambition and who is looking for a permanent position need apply. Address Box No. 54, care of MACHINERY, 9-15 Murray St., New York.

"Does All That Was Claimed For It."



We could'nt have a better recommendation for the Warden Filter than that contained in the reason given by a customer for sending a duplicate order—that the filter did all that we claimed for it. That's the way we sell them—on their own merit. If they don't do just what we say we stand ready to take them back, and no expense to you. If you are interested in oil saving let us send one on trial.

HAMILTON, OHIO.

The Burt Mfg. Co., Akron, Ohio.

Gentlemen:—I am instructed by the President of this Company who is also President of the Hamilton Electric Light Company, to order for their use a duplicate of the oil filter which you furnished for this Company a short time ago. Your filter does all that you claim for it, and hence, the duplicate order.

Kindly make this shipment as promptly as possible, and oblige,

Very truly yours,
THE HAMILTON OTTO COKE CO.
Per GEO. WHIPALL, Supt.

Shelby & Co., London, E. C, Eng., Sole Agents for Great Britain.

The Burt Mfg. Co.

Main & Howard Sts., Akron, Ohio, U. S. A.

"Must Have Another"

The Burt Exhaust Head has nearly as many friends as the filter, because in its own field it is just as good as the filter is, and where we sell one, it is usually a case of "must have another" if the customer has any possible use for another. The Burt is a modern exhaust head built to meet the requirements of a modern steam plant, and never fails to give satisfaction. Sold on the same terms as our filter—if it don't do the work, send it back.

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The Burt Mfg. Co., Akron. Ohio.

Gentlemen:—Please send us one 10 in. Burt Exhaust Head, same as shipped us in December. We assume the price will be the same. We are charmed with the efficiency of the one put in by us and must have another.

Please ship at once if possible.

Yours very truly,
N. LUDINGTON CO.

MACHINERY.

November, 1902.

SHOP CONSTRUCTION.—2.

THE GUIDING CONDITIONS—GENERAL FEATURES OF THE BUILDINGS.

OSCAR E. PERRIGO.

Having arranged and planned the buildings for carrying on the work for which our plant is designed, making each of a size large enough for the equipment to be installed and the number of men required to operate it; and having placed the several buildings in convenient adjacency for economically passing the work through them, from the raw material to the finished product, let us now consider the construction of the buildings planned.

Manufacturing buildings are erected for utility rather than ornament, and the latter characteristic is always made secondary to the practical question of best fitting them for the special work to be done in them. To this end one must be guided by several well-known conditions. First, the buildings should be strong enough to bear the weight and withstand the strain of the machinery operated in them, and the materials used in manufacturing, with which they are loaded. This load frequently varies within a wide range as to weight at different times, and is also constantly being shifted from one point to another, so that provision must be made for this condition. Second, the building must be of such construction as to be amply rigid for all purposes, and to a certain extent be elastic enough to remain uninjured under the shocks that it is liable to undergo. Third, there should be ample opportunity for ventilation, yet not unnecessary height, as the expense of heating would be needlessly increased.

Fourth, ample provision should be made for light, for which purpose the windows should be placed at short intervals and extend nearly to the ceiling. At the same time an extravagant use of glass will also increase the cost of heating. Fifth, the floors should be of such strength and material as to bear whatever weight is to be put upon them, either regularly or temporarily. Sixth, Numerous exits should be provided for the use of employees in case of fire. This becomes more imperative as the number of employees increases in proportion to the area of floor surface; as for instance, in factories, particularly where boys and females are employed.

Seventh, the roofs should be so constructed as to bear the weight of snow in winter, as well as the pressure of high winds; and they should be so designed as to give a minimum amount of after-expense from deterioration and from leaking, the latter cause usually costing much more from damage to stock and machinery than for repairs to the roof itself.

For manufacturing buildings in general there is probably no construction more satisfactory in every respect and that answers all the usual conditions better than brick walls and an iron roof. The walls should be of a thickness proper to the size and purposes of the building, and, except when the building is for light work, should be strengthened by buttresses placed between the windows or groups of windows.

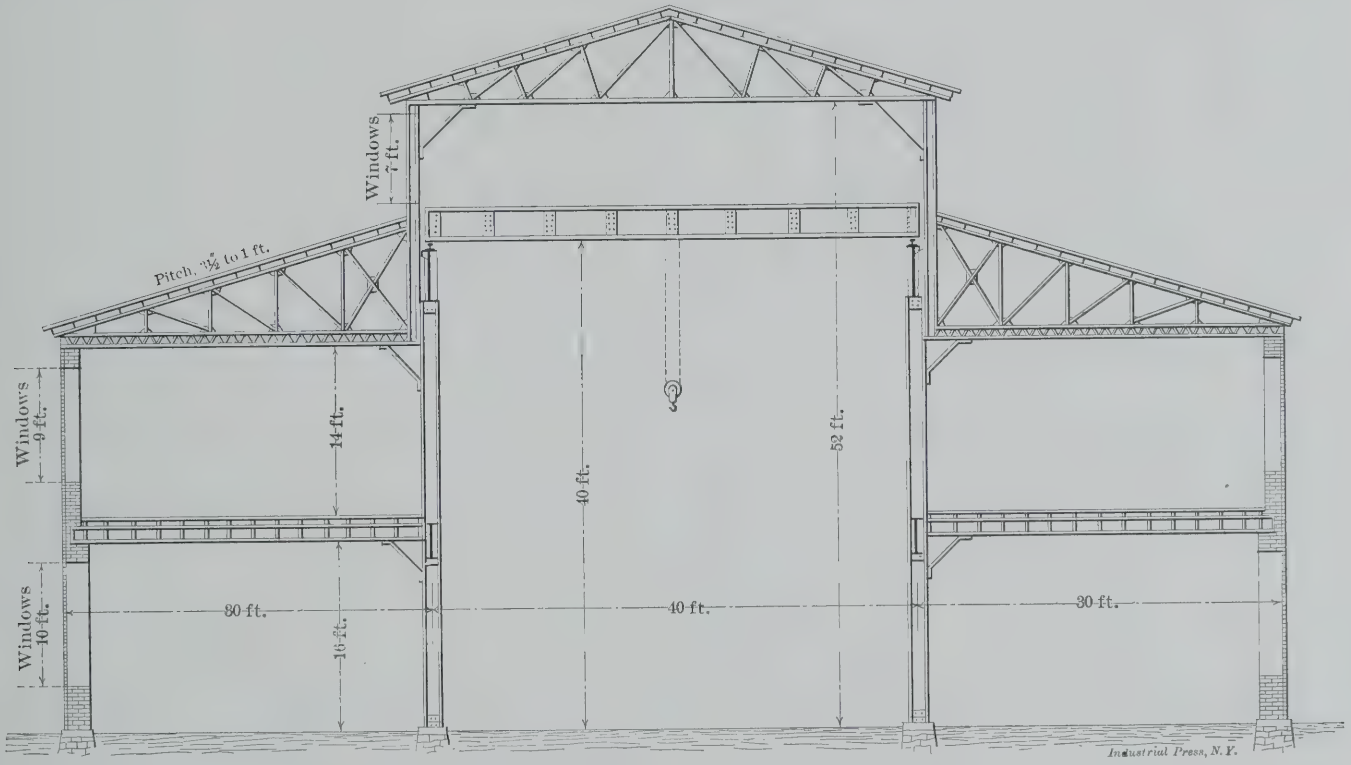

Fig. 1. Cross Section through Machine Shop of Model Plant.

The roof* proper should be supported by trusses at each division or bay, and connected by purlins, all securely braced; by which construction lightness, combined with great strength and ample elasticity is secured. For a covering, wood may be used and covered with roofing tin and always protected by a good coating of mineral paint. The covering may be of corrugated iron, although this has the very serious objection of moisture condensing on its underside and dripping into the interior of the building. This may be wholly prevented by laying on a couple of thicknesses of tar paper, or other paper impervious to water, and as a protection against fire from the underside of the tar paper, first laying two thicknesses of asbestos paper. These four layers of paper are supported by galvanized wire netting, tightly stretched over the purlin supports. This is probably the best form of roof

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* The roof designs shown are substantially those adopted by the Berlin Construction Co., New Britain, Conn.—EDITOR.

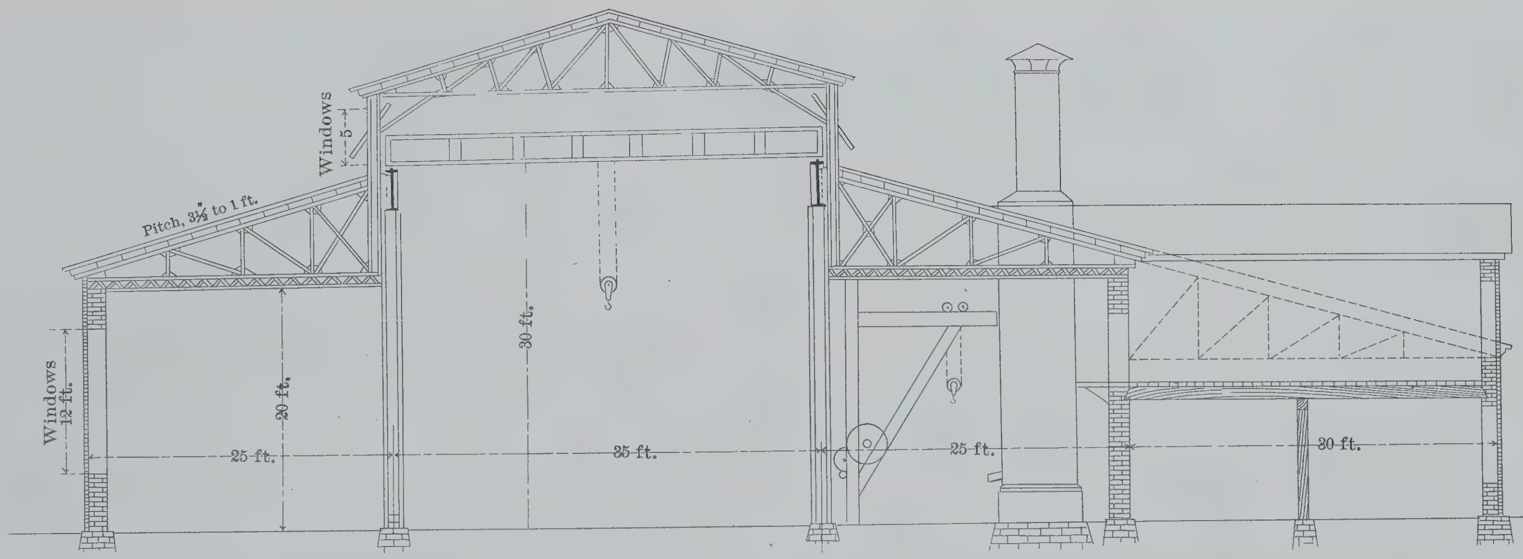
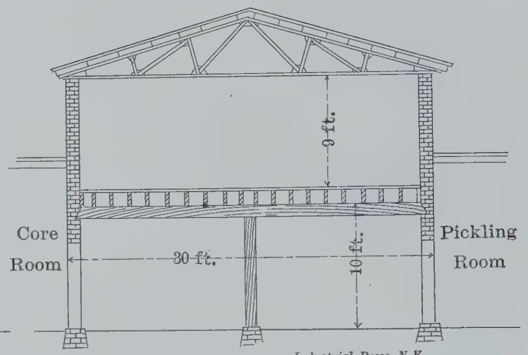


Fig. 2. Cross Section through Foundry, Cupola Platform, etc.



Industrial Press, N.Y.

Fig. 3. Section through Cupola Platform at Right Angles to Fig. 2.

covering yet devised for the roofs of manufacturing buildings, and with brick walls, truss roof and covering as described the building is practically fireproof.

Referring to Fig. 1, the machine shop is seen to be constructed with a central portion 40 feet wide and covered by a traveling crane, giving a clear height of 40 feet beneath it. This crane is supported by wide plate girders resting on the main columns, and runs the entire length of the machine shop. It may be operated by belting and gearing, but preferably by electricity, as the necessary power is much more readily transmitted to any point in the length of the building by conducting wires and a suitable trolley than by means of shafts and belts with their attendant expense and annoyance.

On each side of the central portion of the building are wings 30 feet wide, extending the whole length of the structure, and built in two floors, the upper one, or gallery, being used for light machinery. It extends across the front end, both as a means of conveniently connecting the two galleries and of affording a platform for transferring to and from the ground floor by the traveling crane.

The lower member of the roof truss is of latticed form, to give the required strength for supporting the lines of shafting. The floors of the galleries are supported by girders, upon which floor joists are supported, and to the under side of which the line-shaft hangers are attached.

The side walls are built 20 inches thick for the first story, or 16 feet, and 16 inches thick for the remainder of the height, and are strengthened by buttresses 8 inches projection and 24 inches wide. Each bay, or division, is 18 feet 3 inches centers, and the side wall is pierced for two windows on each floor, each window being 4 feet wide; the lower ones 10 feet, and the upper ones 9 feet high. Above the wing roofs is another series of windows 5 feet high, extending the entire length of the building and separated one from the other only by about 12 inches, thus giving ample light to the central portion of the building. Every alternate sash is pivoted so as to be opened for ventilation.

The roof is constructed as has already been described, with an outward covering of corrugated iron, and has a pitch of 3½ inches to the foot, as have the roofs of all the buildings of the plant. The form of truss is the usual one, as shown in the engravings.

The foundry is built on a plan similar to that of the machine shop, with a central part 35 feet wide and side wings 25 feet wide each. On the cupola side the wing proper is extended 30 feet further, to furnish accommodations for the cupola platform, chipping, core and flask rooms. See Figs. 2 and 3.

The central part of the foundry is covered by a traveling crane supported by plate girders resting on the main columns and having a clear space of 30 feet beneath it, while the side wings are 20 feet in the clear. The operations of the foundry do not require this height, but it is very desirable to have ample space for the steam and gases, incident to "shaking out" the flasks after pouring off. To further facilitate their exit the upper windows 5 feet in height, opening over the roofs of the side wings are all made with pivoted sashes, so as to be readily opened when necessary.

The bays or divisions between columns are 18 feet 6 inches centers. The side walls are 20 inches thick, strengthened by buttresses of 4 inches projection and 18 inches wide, and each bay is provided with two windows 4 feet wide and 12 feet high, affording ample light to the side wings and, by the aid of the ventilator windows, completely lighting the whole interior. The lower member of the roof trusses for the side wings is of latticed form to afford sufficient strength for supporting the cranes, and for trolley hoists at any point needed.

The cupola platform construction is shown in cross-section in Fig. 2 and at right angles with this in Fig. 3. A floor supported by suitable timbers forms the cupola platform proper. This may be constructed entirely of iron, if desired, in order to lessen the liability to damage by fire. The platform should be covered with sheet iron, at least in the immediate vicinity of the cupolas, and should be placed at a proper height to suit the cupolas used. It may be reached by way of an elevator carrying one of the yard tram cars, as will be described hereafter in another article.

The forge shop is built much heavier in proportion to its size than the other buildings, on account of the strains and shocks caused by heavy hammers and drop presses. It is 50 feet wide, 80 feet long and 18 feet high in the clear, and no columns or other obstructions interfere with the free working. The roof girders are strongly built and thoroughly braced, and the lower member made in latticed form for supporting the usual overhead work of the shop. See Fig. 7.

The walls are 20 inches thick and 18 feet high, strengthened by buttresses 8 inches thick for a height of 8 feet and 4 inches the remainder by 20 inches wide. The spaces or bays are 13 feet centers and the wall is pierced for one window to each space. The windows are 4 feet wide and 12 feet high, and located, five on each side, three in the front and one in the rear, making fourteen in all.

The roof ventilator is 12 feet wide and extends the entire length of the building, with openings 4½ feet high, as in Fig. 4.

Along the outer wall are arranged chimneys for six forges. If the system of downward draft is employed these would not be needed, the smoke and gases from all being carried to one chimney conveniently located for that purpose. In consequence of the arrangement necessary for these chimneys, when such construction must be used, the buttresses on this side are placed opposite the chimneys and the windows between. This necessitates the use of a steel I-beam in the wall over the windows for supporting the roof trusses. By reducing the number of chimneys to five, this may be avoided.

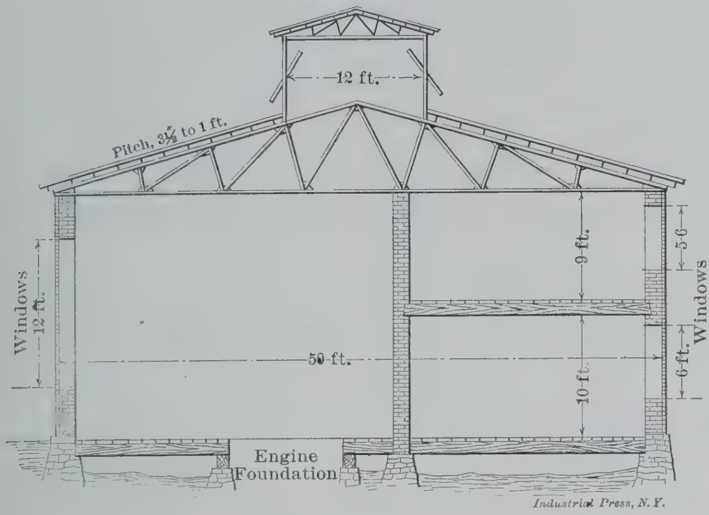


Fig. 4. Cross Section through Power House.

The power house is of construction similar to the other buildings. The walls are 16 inches thick and 20 feet high, with buttresses 4 inches thick and 20 inches wide. 12-inch walls divide the boiler room, engine room, water closets and wash rooms from one another, the last two being built in two floors—the lower one 10 feet and the upper 9 feet high, in the clear. There is a ventilator 12 feet wide, running the whole length of the building, with pivoted windows on each side, 5 feet high, shown in Fig. 4.

When the power required would render it necessary the entire building might be devoted to the boiler and engine rooms, and the wash rooms and water closets be provided for in a side addition. They are placed as shown in order to secure a central location and immediate connection with the machine shop without encroaching on its space. Plenty of light is provided for the wash rooms and water closets by rows of ten windows, 3 feet wide, on each floor, the upper ones being 5½ feet and the lower ones 6 feet high.

The engine room and also the boiler room are lighted by four windows, 4 feet wide and 12 feet high, in the outer wall; while two extra windows are placed in the end of the boiler room for the purpose of giving extra light in the rear of the boilers. In the end of the boiler room is a double door 12 feet wide, one-half of which only need be opened to admit the coal car. Near this door are the track scales for weighing the coal as it is brought in. The tram track is continued the length of the boiler room, in front of the boilers and through the door into the engine room, as a convenient means of bringing in or taking out any small machines such as dynamos or similar apparatus.

The engine room connects with the machine shop by an opening 14 feet wide and 16 feet high, through which engines or large pieces of machinery may be moved, and through which main belts may be run. This space may be closed up, after the power plant is installed, either by doors or by a wooden partition containing suitable doors.

The storehouse for finished machinery, and the carpenter shop adjoining, Fig. 5, are of the same general construction as the other buildings, so far as the walls and roofs are concerned. Both have 16-inch walls, 14 feet high for the carpenter shop and 18 feet for the storehouse, and strengthened by buttresses of 4 inches' projection by 16 inches' width.

The storehouse floor is 3 feet above the level of the machine shop floor. Near the back wall (next to the railway track) the floor is cut out and a specially constructed tram car traverses the space, the top being on a level with the floor. This car track crosses the machine shop floor, and passes over the scales located in it, directly under the traveling crane. By this arrangement machines may be transferred from any point in the shop to this car, standing on the scales, and may be weighed, run into the storehouse and stored away or conveniently run into a car on the railway track, the top of the cars being also on a level with the storehouse floor.

In case the machinery built is of sufficient weight to make such an arrangement desirable, the lower member of the roof trusses should be of latticed form, or, if needed, several of them may be plate girders, in which may run trolley hoists for lifting a machine from the tram car and running it back into the rear of the storehouse or out upon a railway car. The girders may project out over the railway tracks sufficiently to permit of easy handling in loading cars.

Two sliding doors, one of 8 feet and the other of 12 feet in width and both 12 feet high, are provided for shipping convenience. The storehouse is lighted by eleven windows, each 4 feet wide and 10 feet high. Additional windows might be located in the rear wall, over the storage sheds and in the end toward the forge shop if the machinery manufactured was of such small size and such variety as to make a division of the storehouse necessary to properly store and care for it.

The carpenter shop is provided with a sliding door, 6 feet wide in the side, where a branch of the tram tracks enters, and one in each end 10 feet wide. The shop is lighted by thirteen windows, 3½ feet wide and 6 feet high. The roof trusses are placed 15 feet from center to center, the lower members being latticed to afford support for the shafting driving the wood-working machinery. See Fig. 5.

The storage sheds for coal, sand, coke, etc., as well as those for cast iron, steel chips and similar materials, may be built of wood, but a brick construction will be found to be much more satisfactory.

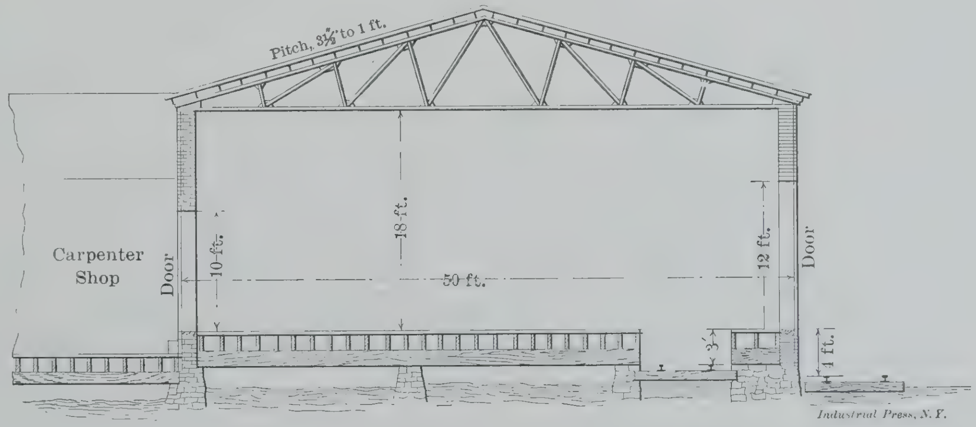


Fig. 5. Cross Section through Store House, Carpenter Shop, Tracks, etc.

The walls should be 12 inches thick and 8 feet high on the side next to the yard. The roof may be what is termed a "gravel roof;" that is, consisting of wooden rafters covered with one-inch rough boards, over which is placed tarred paper, then a coating of well-boiled gas tar, and upon this a layer of gravel stones of from ⅛ inch to ⅜ inch diameter and perfectly free from dirt. This roof should have an inclination of one inch to one foot, although slightly less is often used.

For the coal and sand sheds the openings in the walls may be 3 feet high, beginning just under the roof, and 6 feet wide, on the side next to the railway track. These should be closed by hinged doors of two thicknesses of ⅞-inch boards, the grain of each thickness crossing the other at an angle of 45 degrees.

On the side of these sheds, next to the yard, sliding doors, hung from the top and usually not over 10 feet wide, are most practical. To be substantial they should be made as described above, of two thicknesses of ⅞-inch boards.

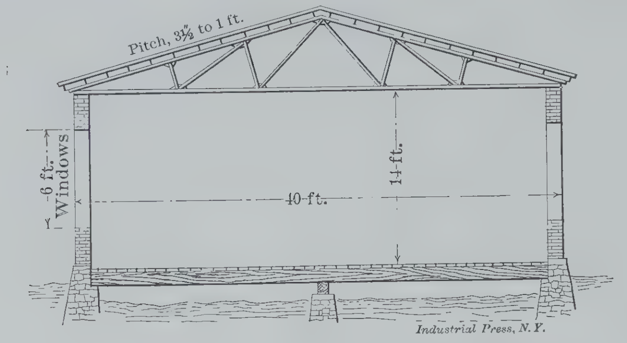


Fig. 6. Cross Section through Carpenter Shop.

Inside of these and about a foot from them planks 12 inches wide and from 2 to 3 inches thick should be set on edge, to sustain the weight of material behind them. These should be fitted in grooves at the ends so as to be easily removable, as occasion may require, and they may have a central support of a scantling set in a hole in the floor and properly supported at the top.

The floors of these sheds may be of 2-inch planks, supported by scantling 4 x 4 inches, laid 18 inches from center to center. But much better than this, and cheaper in course of time, will be brick paving, laid as will be described in a future article on floors.

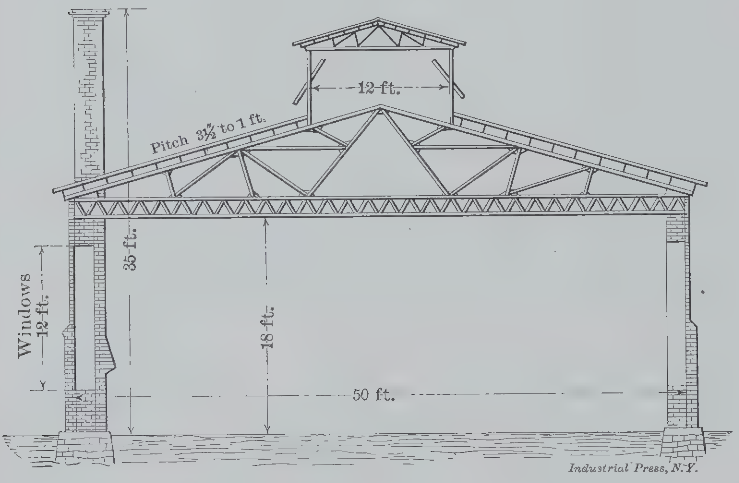


Fig. 7. Cross Section through Forge Shop.

The construction of the shed in the rear of the forge shop should be as described above, except that there will be wood floors for the wash room and water closets.

The questions of foundations and floors have been here omitted and will form the subject of another article of this series, wherein will be considered various forms of floors, both of wood and other materials, and wherein some of the reasons for the failure of many of them now in use will be pointed out.

* * *

The accurate determination of high temperatures involves the use of expensive and delicate instruments, known as pyrometers. For determination of muffle temperatures the following observations made by Violle will give very approximate results: Fireclay just glowing in the dark is at a temperature of about 525 deg. C.; dark red, 700 deg.; cherry red, 900 deg.; bright cherry, 1,000 deg.; orange, 1,150 deg.; white, 1,300 deg. To convert degrees centigrade into degrees Fahrenheit multiply by nine, divide by five and add thirty-two: Thus, 1,000 deg. C. equals 1,832 deg. F.—*Mining Reporter.*

STEEL AND ITS TREATMENT.—3.

ANNEALING.

E. R. Markham.

According to the generally accepted definition of the term the object of annealing steel is to soften it, so that it may be machined at the minimum cost of labor and tools. Steel is annealed by heating red hot, and cooling *slowly*. The greater the amount of time consumed in the cooling operation the softer the steel will be—everything being equal.

The method pursued when annealing steel depends, as a rule, on the facilities which the shop possesses for doing the work. A piece of steel may be softened somewhat by heating red hot and laying to one side to cool in the air. It must not, however, be placed on any substance that will chill it, nor where any current of air can strike it, or it will cool too quickly to become softened; in fact, it will very likely be harder than if worked without attempting to anneal it.

The young hardener should understand that a piece of steel is hardened by heating red hot and cooling *quickly;* the more rapid the process of cooling the harder the steel will be. With annealing the process is just the opposite; the steel is heated red hot and allowed to cool *slowly*, and the slower the cooling operation the softer the steel will be. Now it is evident that if a piece of steel be heated to a red and laid on an anvil or other piece of cold metal, or thrown on the floor, the portion lying on the cold substance will chill, and the process of hardening, instead of annealing, takes place. The same is true if the piece be placed where a current of air can strike it, even if it is warm air; for it will be cooler than the steel, and the heat in the steel will be taken up by the air.

It is the custom in many shops to anneal steel by heating and putting in a box of ashes or lime. Now this may or may not be advisable, according to the condition of the contents of the annealing box. If the room in which the box is kept is damp, the ashes or the lime—especially the lime—will absorb enough moisture to chill a piece of red hot steel, particularly if it be a small or thin piece. When steel is to be annealed by this process heat a piece of iron or scrap steel and bury it in the ashes or lime, leaving it there until the piece to be annealed is properly heated. Then remove and put the piece to be annealed in its place. The ashes or lime being hot and every trace of moisture removed the process of cooling will be slow, and the results satisfactory. A box of lime furnishes an excellent means of annealing steel, if the precaution mentioned is observed.

A very satisfactory method of annealing, which has been used by the writer many times, where there were only one or two pieces to anneal at a time, is as follows: Take an iron box; put two or three inches of ashes in the bottom. On this lay a piece of board a trifle larger than the work. Heat the pieces to the proper degree, lay them on the board, put another piece of board on top of them and fill the box with ashes. The pieces of board will smoulder and keep the steel hot for a long time. The process of cooling will be very slow.

There is a method of annealing practised in some shops which, while it has many advocates, can be recommended by the writer only as a means of annealing a piece of steel that is wanted for immediate use. It is known as cold water annealing. The steel is heated to a red and allowed to cool in the air where no current of air can strike it. It is held in a dark place, and when every trace of red has disappeared it is plunged into water and left until cold. The steel will be softer if plunged into soapy water or oil. This answers in an emergency, but owing to the liability of the ends cooling faster than the center, and the smaller portions cooling more rapidly than the larger ones, it is evident that the steel when chilled must be of an uneven temperature throughout.

The method used in many shops of heating a piece of steel in a furnace using gas, oil or gasolene as fuel, to the proper annealing heat, then shutting off the supply and allowing the work to cool down with the furnace, is attended with varying results. While many mechanics advocate this method and claim excellent results, and while it has been used by the writer to his satisfaction, yet quite a number of cases have come to his notice of late where persons had annealed in this way with results that were far from satisfactory. An investigation showed that in heating the steel the furnace had been forced in order to heat the piece quickly. As the steel was heated by radiation it was necessary that the walls of the furnace or the muffler should be hotter than the piece of steel being heated. When the steel had apparently reached the proper heat the supply of fuel was shut off; but the inside walls of the furnace being much hotter than the work, imparted heat to the steel after the fire was put out, with the result that the steel was overheated and injured, and in some cases entirely unfitted for use.

A steel maker of national reputation says that "many thousands of dollars' worth of steel are ruined annually in this way, and it is in every way about the worst method of annealing that was ever devised." Consequently the writer feels it his duty to condemn in no uncertain words a method he had successfully practised under favorable circumstances, because mechanics are not all so favorably circumstanced and do not use sufficient care in heating steel. Very especial care is necessary when it is nearly to the proper heat, but most men insist on forcing it; and this is detrimental to the edges and corners, which will heat faster than the center, and to the whole piece. For if the furnace is hotter than the steel, then when the fire is extinguished the furnace is closed and there is no means of looking into the oven to determine the amount of heat the steel is receiving.

A method of annealing that gives universal satisfaction—when properly used—and that is employed in many shops, consists in packing the steel in iron boxes, filling the spaces between the pieces of steel with powdered charcoal. In this method it is necessary to place one or two inches of charcoal in the bottom of the box before putting in any steel, and the pieces of steel should not come within one-half inch of each other in the box, or within one inch of the box at any point. When the box is nearly full, fill the balance of the space with charcoal, put on the cover and seal with fire-clay. The steel should be kept from coming in contact with the boxes, because iron—especially cast iron—has a great affinity for carbon and will, when the steel and iron are both red hot, extract this carbon from the steel, leaving the steel somewhat decarbonized at the point of contact.

To determine when the contents of the box are heated to the proper degree several ¼-inch holes should be drilled through the center of the cover and a 3-16-inch wire run down through each of these to the bottom of the box. When the work has been in the fire (according to the judgment of the operator) long enough to heat through, draw one of them by means of a pair of long-handled tongs or with a pair of ordinary length, slipping a piece of gas pipe on each leg to give the required length. If the wire shows hot the entire length the operator may rest assured that the steel is of the same temperature, because the wire was run down between the pieces in the center of the box. If the wire does not show red hot he must wait a while then draw another. When a wire is drawn that shows the proper degree of heat the box should be left long enough to insure the steel being heated uniformly throughout; then the fire may be extinguished. If the walls of the furnace are much hotter than the boxes the door may be left open until they are somewhat cooled. If the furnace shows a disposition to heat the boxes too much with the door open the box may be removed for a few minutes until the furnace is somewhat cooled. Then the box may be returned to the furnace, the door closed and the work allowed to cool slowly.

A way to insure excellent results is to plan to empty one furnace of work to be hardened some little time before the work being annealed is sufficiently heated. Keep the first oven closed to retain the heat as much as possible; but it will pass the stage where it is liable to overheat the articles and will commence to cool down somewhat. When the work has been subjected to the heat for a sufficient length of time the boxes may be removed from the oven they were heated in and placed in the first oven. All danger of overheating from radiation is then done away with. This cannot, of course, be practised where there is but *one* furnace.

While it is generally understood that the object of annealing steel is to make it soft enough to work to advantage, yet from the hardener's standpoint annealing has another and more important office than simply to make steel workable. A piece of steel as it comes from the steel mill or forge shop is very apt to show a difference of grain in its various parts, due to uneven heating and unequal closing of the pores from the process of rolling or hammering. Consequently there exist internal strains in the piece. To overcome the effects of these internal strains, which must manifest themselves when the steel is hardened, the work should be blocked out somewhere near the shape and annealed. If the piece is a milling machine cutter, punch press die or similar tool, having one or more holes through it, the holes should be made, but somewhat smaller than finish size, before annealing to remove strains. If it is a milling machine cutter of irregular contour it should be blocked out as represented in Fig. 1. The finished cutter is shown in Fig. 2. The benefit gained in pursuing this course is that, so far as shape is concerned, it is heated for annealing under—as nearly as possible—the same conditions as when heated for hardening. Consequently the tendency to change shape will be overcome in the annealing.

Long pieces of steel to be hardened will give much better results if roughed out. Remove all scale or outside surface by turning or planing, then thoroughly anneal. Should the piece spring when annealing do not straighten it cold, as it is almost sure to spring when hardened. If it is not sufficiently large to turn out without straightening, it should be heated red hot and then straightened.

The hardener is blamed many times because a costly reamer, broach or similar tool is crooked in hardening when in reality the blame rests with the man who turned it or planed it to size. After it is annealed he tests it in the lathe, and, finding it running out somewhat, he takes it to an iron block or an anvil and commences to hammer it. He finally gets it to running very nicely and feels quite proud of his job. He doesn't like to see a man turn or plane a piece of steel which runs out even if it will finish out, when a few strokes of a hammer will "fix it all right." But by means of the hammering he has set up a system of internal strain much more serious than the one removed by the process of annealing. He now commences to machine the piece; every time he goes below the effects of a hammer mark the piece goes in some direction at this point, and it is necessary to repeat the operation of "hammer persuasion" again, with the result that by the time the article is ready to harden it is in no condition to be hardened. It is either crooked in all directions, or it is only waiting for the fire to relieve it and allow it to go where it will.

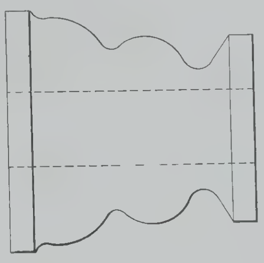
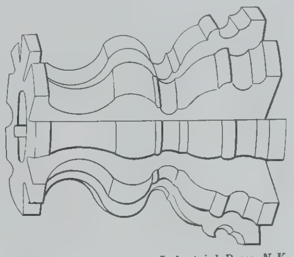


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

When the hardener gets through with it, it looks like a "cow's horn." And, of course, the hardener is to blame. If he happens to be a man without machine shop experience or does not understand the nature and peculiarities of steel he does not know where to place the blame—and perhaps it would do no good if he did. But he, of course, is not going to shoulder it; so the fault is laid to the steel. Consequently, if the trouble continues, another make of steel is bought, because the men in charge do not know or cannot spend the time to locate the trouble. "It cannot be the fault with the men in the shop," they say. "It *must* be the steel." Or, again, they decide it must be the hardener, because some other concern with whom they are acquainted use this same steel and have no trouble. So the hardener, poor fellow, must bear the brunt.

A successful business man is quoted as saying: "If I were to drive a mule team I would study the nature of mules." To be a successful hardener a man must study the nature of steel; he must know what steel is liable to do under certain conditions, and how to avoid undesirable results, no matter whether it relates to his department or some other department. He should know that it is possible for the toolmaker to so treat steel that results anything but satisfactory *must* follow when it is hardened; that he may make the steel unfit for use by overheating when annealing or by not heating uniformly throughout when annealing. If a satisfactory steel is furnished the hardener should never blame the steel for bad results caused by his ignorance or carelessness. The next time he may be furnished with an undesirable steel, and after a while those over him in authority will tire of complaints about a steel that another concern is satisfied with.

In some shops they pack the article in a box with cast iron dust or chips. Now this method works nicely when annealing forgings or other pieces of *machinery steel* which were hard and showed glassy spots and could not be softened by the ordinary processes of annealing. The cast iron seems to have an affinity for the impurities liable to be present, and the result is very soft, easily-worked pieces. But if this method is applied to *tool steel* the carbon, as we stated before, is extracted to an extent that is highly injurious to the steel. To be sure, tool steel can be annealed very soft if packed as described, but the results are anything but desirable.

Another way to anneal machinery steel is to pack the pieces in the annealing box in expended bone—that is, bone that has been previously used in casehardening. This is also an excellent way of packing cast iron that requires annealing, such as small castings for typewriter parts, etc., which must be very soft in order to machine nicely. But tool steel should never be packed in any form of bone, as bone contains phosphorus, which is the most injurious of any of the impurities tool steel may contain. The steel maker uses every effort possible to reduce the percentage of this impurity to the lowest point; for, while it is a hardening agent, its presence makes tool steel brittle. And it is folly to pay a high price for steel which the manufacturer has spent much care in ridding of undesirable impurities and then to use a method whereby the steel will be charged with these very impurities.

In conclusion, it may not be amiss to emphasize a few facts that have already been mentioned. Do not overheat steel when annealing, or it will be *permanently* injured. Do not subject it to heat for a longer period of time after it becomes uniformly heated throughout than is necessary to accomplish the desired result. For while it is essential, when annealing, to heat to as high a temperature as for hardening and for a period of time that insures its being of the same temperature in the middle of the piece as it is at the surface, yet care must be taken not to overdo it. Steel kept at a red heat for a long time, even if not overheated, will betray the fact when the temper is drawn, if not before. It may to all appearances harden all right, but when the temper is drawn the hardness apparently "runs out." For instance, when the piece is heated to a straw color it can be filed very readily; whereas a piece from the same bar not annealed, or that has been annealed properly, then hardened and drawn to the same temper color, would show all right; that is, a file would just catch it.

Uniform heating when heating for annealing is as desirable as when heating for hardening. If in a large block the corners and edges are hotter than the main part violent strains are set up at these points. It is therefore readily apparent that uniform heating is one of the secrets of successful handling of tool steel.

Lastly, remember that any process of annealing which takes from the steel any of its hardening properties is not fit to use, no matter how soft it may make the steel. It is better to work a piece of steel which is hard than to unfit it for doing its maximum amount of duty when finished. But it is possible to anneal most steels so that they will be workable and yet harden in a satisfactory manner; in fact, in a much more satisfactory manner than if not annealed.

The writer wishes it understood that these articles deal entirely with *carbon steels*, and not with the so-called self-hardening steels. These are very valuable, but are not under consideration at this time.

NEW WORKS OF THE B. F. STURTEVANT CO.

GENERAL FEATURES OF THE PLANT AND THE CONSIDERATIONS WHICH LED TO THEIR ADOPTION.

The new works of the B. F. Sturtevant Co., now nearing completion at Hyde Park, Mass., present an excellent opportunity to study the factors that control in the location and design of a modern manufacturing plant. The present plant at Jamaica Plain, Mass., is too small for the business and has no room for growth. A fire, which nearly destroyed the whole plant a year ago, forced an immediate selection and a site of 20 acres was procured at Hyde Park, Mass., six miles from the present location, the home of several prominent machine works. In deciding upon the new location, the claims of the West were weighed against those of the East, but an abiding faith in the future prosperity of New England and the fact that a large number of skilled mechanics are available in the vicinity of Boston, won out in the end, in spite of the somewhat higher rates for raw material in the East. The lot selected has a frontage of 1,300 feet on the N. Y., N. H. & H. R. R., and one side is bounded by a large brook, which will supply water, and there is ample space for dumping waste material.

In laying plans for the buildings, the head of each department was consulted, his recommendations reduced to writing, and frequent conferences were held. With these data at hand the plans were started with the idea of providing a total floor space slightly more than double that of the present plant. The lay of the land and its available area being somewhat against a group of one story buildings, and a simple calculation showing that the actual cost of the power expended in a single year for lifting the entire product of the works through a distance of 20 feet figured only a very small sum, determined the company upon the erection of multi-storied buildings. The character of their products readily lent itself to such a design, and it was believed that the expense in going from floor to floor would be more than offset by a reduction in the horizontal distances necessary to be traversed.

The arrangement of the buildings was determined by the provision to be made for growth. One arrangement of a series of parallel buildings permitted increase only by multiplication of buildings, but provided an excellent opportunity for the carrying of switch tracks across both ends of each building. The other arrangement provided for a group of buildings parallel to the railroad tracks, with accommodation for switch tracks between buildings, and for their entrance at the ends of the building, with an opportunity for growth by extension in length, and this was the plan adopted.

For the construction of the buildings the latest all-steel and concrete type with large window areas did not appear to meet the requirements of the group. All steel buildings, brick walls and concrete fire-proof floors presented disadvantages in the way of discomfort to workmen, inconvenience in attaching machines on hangers, and excessive expense which did not appear to be offset by advantages to be secured in the way of absolutely fire-proof construction. The type finally selected is composite in its character, consisting of steel interior columns and main steel girders, with heavy brick walls, wood timbered floor and plank roofs. In the case of the one-story foundry, the roof is supported by steel trusses; in the other buildings open timbering with wooden columns in the upper floor is employed. The main floor in the machine shop is of tar concrete with spruce and maple flooring. The upper floors are carried upon wooden beams spanning the spaces between the steel girders, which follow a unit system of 20 feet on centers through the building. All roofs are of 3-inch plank with tar and gravel top.

The question of power was early decided to the extent that the entire plant would be electrically driven from a central power house; that the engines would run condensing; that the exhaust steam derived from engines under test, which is considerable, would be utilized for heating, with supplementary amount of live steam admitted at reduced pressure as might be required. The power house was placed sufficiently far from the ends of the buildings to permit extension of each, and near to the water supply.

The pattern building provides at one end a two-story portion 80 feet square for carpenters and flask makers on the first floor, and for pattern makers upon the second floor. The balance of the building which is devoted to pattern storage is provided with intermediate floors, making four in all, separated from the other portion of the building by double fire walls and automatic fire-closing doors. The close proximity of this building to the foundry facilitates rapid intercourse.

The foundry, 170x350 feet in dimension, is designed with the idea of distributing iron upon a track system, and is to be equipped with narrow gaged railways bedded in concrete, making runways between the moulding floors. Two craneways run lengthwise of the building through the greater part of its length, and the tracks extend beneath the crosswise traveling cranes in the cleaning room at the end of the building. The brass foundry is located in one corner, a wash room in the adjacent corner, a core room between the two; the latter has ample opportunity for growth towards the center of the foundry, while the foundry itself can be extended to practically double its length. Storage for supplies is provided upon one side adjacent to the railroad switch. From the bins thus provided, the iron and fuel charges will be carried directly to the charging floor.

From the foundry the castings will pass to the rear of either the machine shop or the fan shop. The former is of the familiar gallery type, 500 feet long, with wings 40 feet wide, and central runway of the same width for crane of 20 ton capacity. The lighting will be principally by a series of sawtoothed skylights running crosswise of the roof, with glass facing due north. The crane will serve the entire floor and transport heavy castings from the machine tools to the erecting floor. Here the completed engine or generator may be lifted upon a transfer car passing through the testing building, and there picked up by another 20-ton crane which will drop it upon the testing plate and subsequently carry it forward to the steam railway track which passes through the end of the building and provides space for the loading of two cars at a time. The upper floor of this building, together with portions of the adjoining buildings, is devoted to the electrical department and provided with individual small traveling cranes.

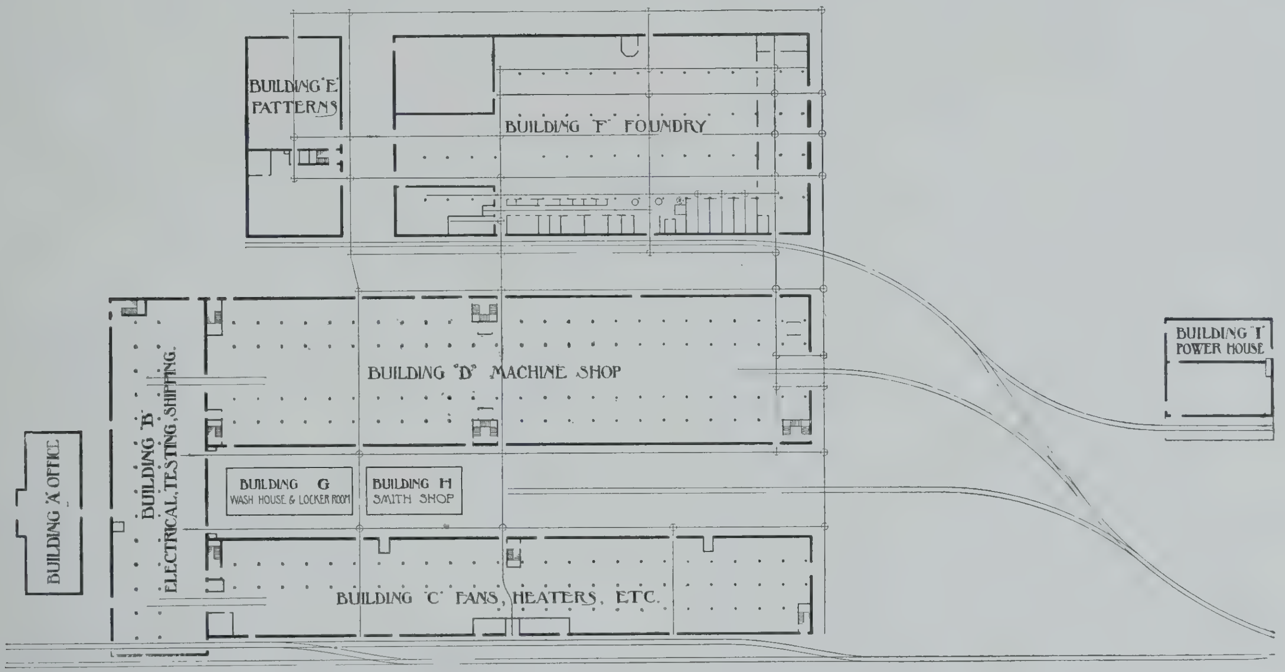
The building devoted to the manufacture of fans, heaters, etc., is 80 feet in width, of the same length as the machine shop (500 feet), is three stories in height, of typical mill construction, with conveniences for handling material and arranged so that shipment can be made from numerous points along one side, while supplies are brought in from the court between it and the machine shop.

The smith shop, 40 feet by 80 feet, serves both buildings with equal facility while the wash house and locker room, measuring 40 feet by 100 feet and three stories in height, is so located as to reduce to a minimum the distance to be traversed by the individual workman. The third floor will be used as a lunch room.

The standard first floor height in the main building is 17 feet, that of the second and third stories is 15 feet. The windows are large and numerous.

The office is to serve as headquarters for the entire business. It will contain the correspondence, designing and drafting offices, the superintendent's quarters, the cost department, the advertising bureau, and a printing office which will be located in the basement. It will be three stories in height with a finished attic to provide additional drafting room space.

The equipment of this plant will be largely "Sturtevant" in its character. Beginning with the power plant, the mechanical draft apparatus, the engines and generators and the exhaust head will be of Sturtevant make. The buildings will be heated by the Sturtevant system; the shafting and individual machines driven by motors of the same make; the removal of refuse from the wood working machinery, the dust from the foundry cleaning room, the ventilation of the offices, toilet rooms, and wash house, and the removal of smoke from the smith shop will be accomplished by Sturtevant exhaust fans. Sturtevant blowers will be used for brass and iron foundry, forge shop blast and the like, and Sturtevant steam traps will be employed upon the steam drivers.


BUILDING "E" PATTERNS
BUILDING "F" FOUNDRY
BUILDING "D" MACHINE SHOP
BUILDING "I" POWER HOUSE
BUILDING "A" OFFICE
BUILDING "B" ELECTRICAL, TESTING, SHIPPING.
BUILDING G WASH HOUSE & LOCKER ROOM
BUILDING H SMITH SHOP
BUILDING "C" FANS, HEATERS, ETC.

Floor Plan of New B. F. Sturtevant Works.

INSURANCE CANCELED BY AN OWNER BECAUSE HIS BOILER WAS UNSAFE.

"If you don't play in my yard I won't play in yours" indicates a spirit that is not by any means confined to childhood. But it is a little strange that business men should allow such considerations to influence them in so important a matter as steam boiler inspection and insurance, as related in the following extract from *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Co.:

> We recall a meeting of certain commissioners, held in a town, a little while ago, at which a report was read concerning a stone crusher boiler that was insured by the Hartford company, and which had been recently inspected. The inspector reported that the boiler was in bad shape, and that it would be more economical to buy a new boiler than to make the extensive repairs that would be required to put the old one in good order. The commissioners at once voted to cancel the insurance on the boiler in question. It would appear that when a report of that kind had been received it would be a good time to continue the insurance as long as the insurance company would carry it, or at least until such time as measures could be taken to put things in proper shape; but we cannot pretend to have the combined wisdom of an entire commission, and so we bow as gracefully as possible to the decision. We may add, however, that we never shed any tears of regret when a patron discontinues his insurance on such a boiler as this. We may also add that if the boiler should blow up, the commissioners would stand in an unenviable position, if they do not take immediate proceedings, on their own initiative, to fix the boiler up, or replace it. Ignorance is never a very good excuse, but when one cannot make even that plea he is in a bad way, so far as moral responsibility is concerned.

NOTES OF TRAVEL.

AN ENGLISH SCALE-MAKING FIRM—A SHOP BUILT BY JAMES WATT—RELICS OF THIS NOTED INVENTOR.

Editor MACHINERY:

In a very attractive album issued by W. & T. Avery, Ltd., of Birmingham, England, builders and manufacturers of weighing machines and steam engines on the site of the Soho Foundry of James Watt, the following occupies the only page of reading matter:

A Short History of the Progress of W. & T. AVERY, LTD.

Birmingham is the center of the weighing machine trade of Great Britain, comparatively little being made elsewhere, and here the business now known all over the world as W. & T. Avery, Ltd., was established in the year 1730. Like many other old businesses it was commenced in quite a small way in Digbeth, one of the most ancient streets of the town. From its inception as a workshop for making steel yards, it gradually grew; other forms of scales and apparatus, including Avery's agate bearings, being added to its list of productions, and the premises continually increased until in the year 1854 Messrs. W. & T. Avery built the first shops of their new factory in Mill Lane, which has in turn continually extended from time to time. In 1868 they purchased the Atlas Works, West Bromwich, where their iron founding was done.

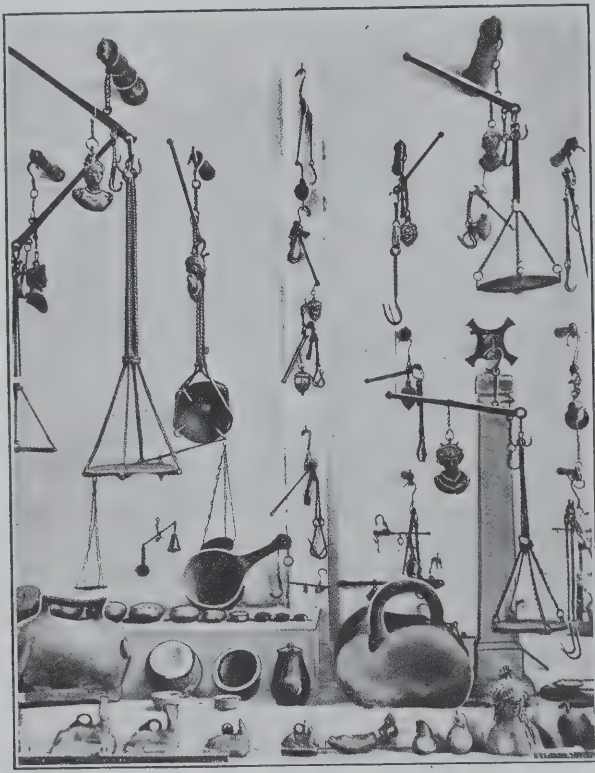


Fig. 1. Weighing Appliances over 2000 years old, found in the Buried City of Pompeii. Highest Weighing Capacity 120 Pounds.

The combined works stood on between 16,000 and 17,000 square yards, most of which were covered by shopping three or four stories high, fitted with machinery of all kinds, driven by five engines of various sizes.

In 1891, Messrs. Avery, finding their business still increasing by leaps and bounds, registered it as a private limited company, and in 1894 as a public company under the title of W. & T. Avery, Ltd.

In 1896, the directors considering the works in Mill Lane at West Bromwich too small for their ever-increasing trade, purchased the Soho foundry made world-renowned by the great James Watt. There they erected extensive buildings upon twenty acres of land, and during the following two years concentrated there their different factories. An extensive plant of special machinery was installed in each department, to insure the most accurate and economical results.

The company employ about 2,000 hands, their production ranging from the finest scientific balance weighing "in vacuo" to the greatest locomotive weighbridge capable of indicating a load up to 180 tons.

The great engineering business of James Watt & Co. is still carried on under the aegis of W. & T. Avery, Ltd.

Messrs. Avery have opened branch works in London, where chemical, assay and other fine balances are made; and in Glasgow where weighbridges are constructed for the Scotch and Irish markets. They have also branches in the principal towns of the United Kingdom.

An inspection of the works under the guidance of the manager convinces one that in the main, the establishment is very much up to date, measured by the gage of an American engineer and manufacturer. The few points in which there is room for modernizing are well known to the manager and he avers that improvements thereon are under consideration. The chief desideratum is quick-acting and powerful hoisting and conveying appliances. The traveling power cranes that are now in use are driven by either one or the other of the power-devouring agencies—the flying rope or the square shaft. Several of the cranes are hand driven.

The old shops of the engineering department, built and used by James Watt, form a striking contrast with the other buildings, well lighted and fully equipped with the appliances of heating and ventilating.

Only a small portion of the engineering department's work is done in these old shops, which are but a small part of the buildings. A few of the tools of this department are very old but are retained on account of being very useful at times. One of a design unknown in modern machine tools, is a wall planer. The guides along which the cutting-tool carrying the head travels can be seen in the view of "the present erecting bay" attached to the wall just beyond the faceplate of the large engine lathe in the right hand foreground of the cut, Fig. 10. The cutting stroke of the tool is parallel to the wall. It can readily be seen that such a tool would be of little service in any locality where there are great temperature changes acting on the wall and its foundations. It is a better machine for England than for the States.

The heavy scales for weighing horses, cattle, wagons, etc., differ from those of the States in having every part made of metal. No wood is used for any part, be it beam, girder, platform, or casing for the recording parts.

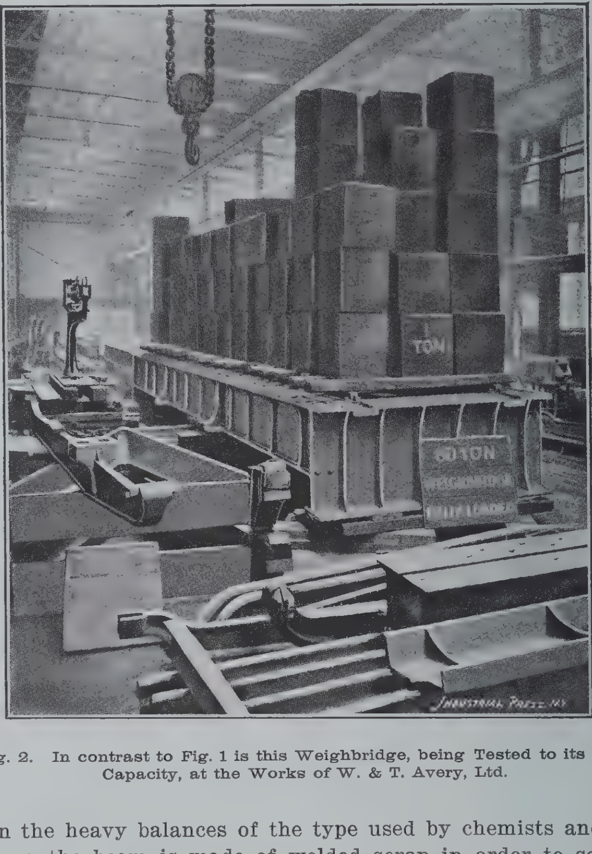
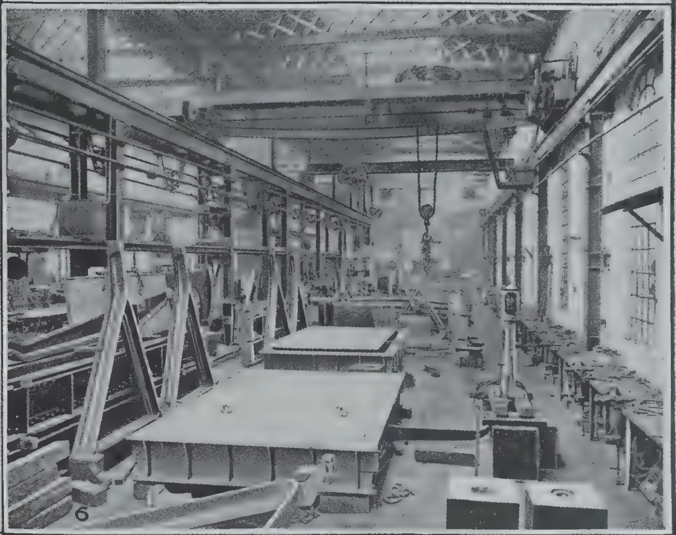
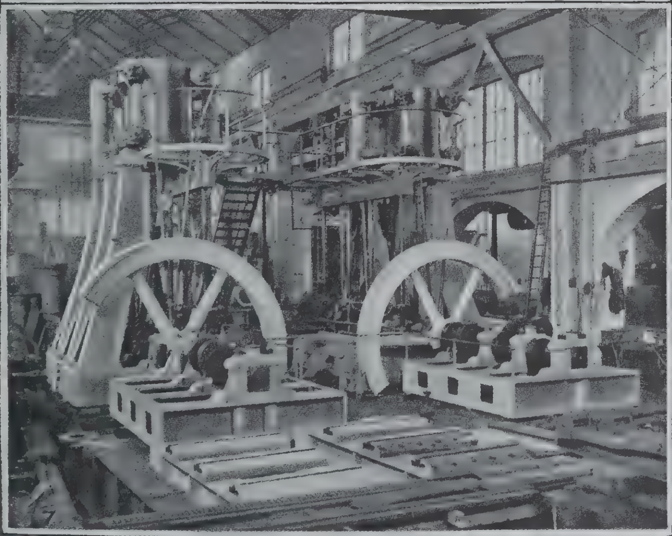
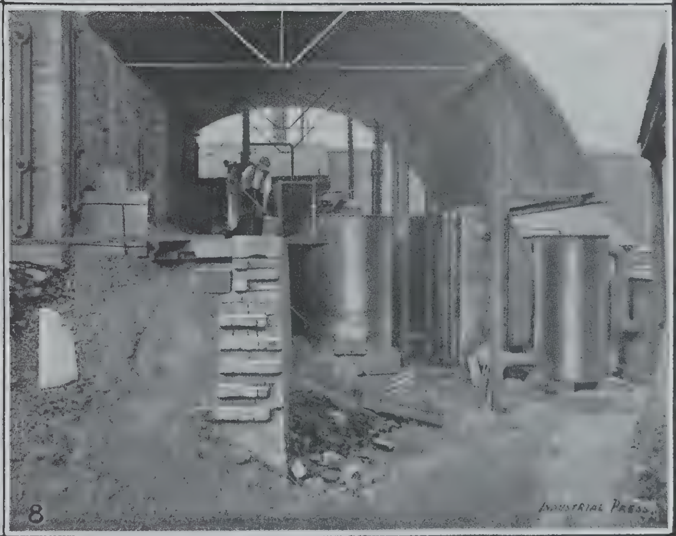


Fig. 2. In contrast to Fig. 1 is this Weighbridge, being Tested to its Full Capacity, at the Works of W. & T. Avery, Ltd.

In the heavy balances of the type used by chemists and assayers, the beam is made of welded scrap in order to secure the greatest toughness. Such balances are used for weighing articles of considerable weight in England, such as bales of cotton, crates, heavy boxes, etc., a use to which this type is not applied in the States.

Continuous weighing and recording machines for grain, coal, ore, etc., are an important part of the product.

The heating of the air for warming the shops is done by a method not common in the States where steam coils are used generally. At Avery's the air is drawn through a large furnace, chiefly of brickwork, located entirely outside of the buildings. The heated air is distributed in each building by metallic pipes with openings and short lengths of pipe on the upper side, so that the air is forced out toward the ceiling or upper region of the space to be heated. This is the reverse of the common practice in the States for heating large shop rooms, which is to carry the air down through branch pipes or outlets from the main, and blow it out toward the floor.

VIEWS IN THE WORKS OF W. & T. AVERY, LTD., BIRMINGHAM, ENGLAND.

Fig. 3. Main Entrance.

Fig. 4. Drawing Office.

Fig. 5. Platform Weighing Machine Department. Fitting and Erecting Bay, 300 x 70 feet.

Fig. 6. Weighbridge Department. No. 3 Bay, 200 x 30 feet.

Fig. 7. James Watt & Co. Showing a Pair of Triple Expansion Pumping Engines in course of Erection. Supplied to the Birmingham Canal Navigation in 1899.

Fig. 8. Gas Making. At the rear of this apparatus James Watt erected a gas plant.

A gas reservoir or tank installed by Watt is still in active service. It differs only slightly from those in common use to-day. The chief difference is in the supports of guiding wheels for holding the inverted cup-shaped tank in position and for keeping it from toppling over. Instead of a connected framework for supporting the wheels, each vertical set of wheels is supported by an individual column of its own. The lower part of the column is of heavy masonry, capped by a comparatively short openwork casting. Each column is self-sustaining. A rod or pipe extends up through the middle of the tank also for the purpose of guiding and sustaining it.

A line of pipe led from the tank to Watt's residence, a mile or so away on a neighboring hill. His house is supposed by the Averys to be the first residence ever lighted by gas. The tank is in the rear of the gas-making part of the plant shown in Fig. 8.

James Watt Relics.

In two small rooms of the Tangye Co., of Birmingham, England, is a collection most interesting to the engineer. It consists of a lot of letters, account books, records, models, drawings, etc., that were the property of the Watt & Boulton Co. during its existence. They were purchased by the Tangye Co. at a sale of the goods of the old Watt & Boulton Co. The rooms are kept closed for the most part, and the material is not arranged in any way, but stored in boxes, drawers and cases in the condition in which it was when it first reached the rooms.

During a couple of hours spent in looking through these relics a number of interesting things were found.

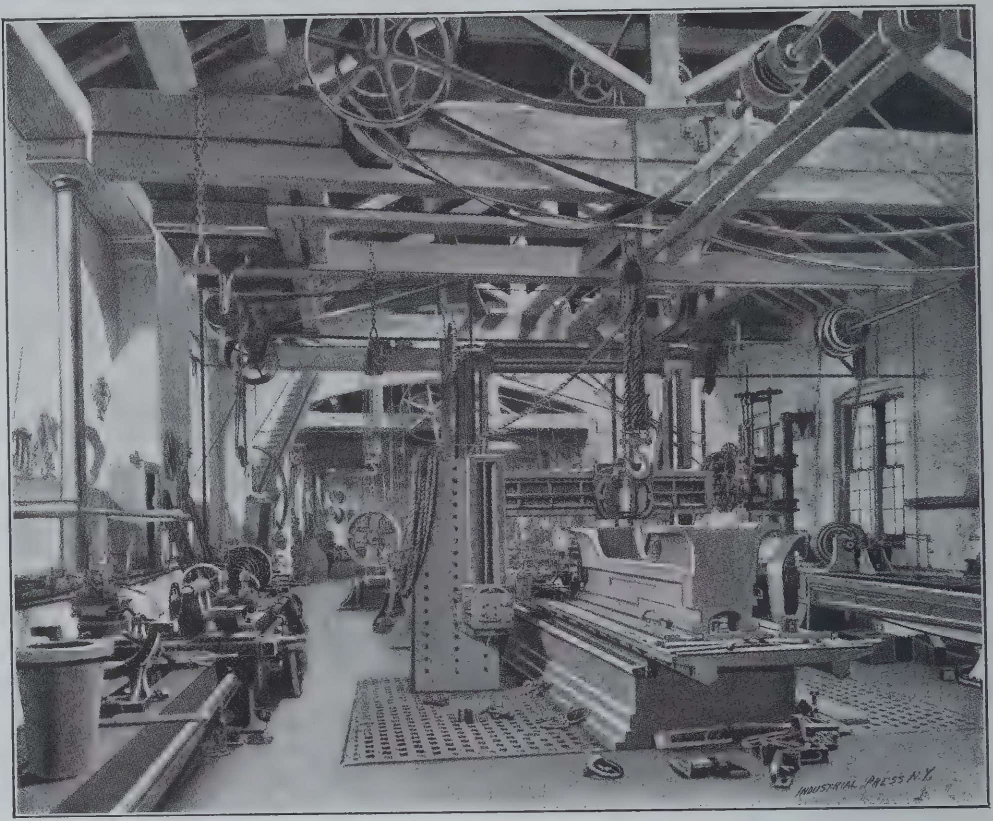


Fig. 9 Engineering Department James Watt & Co. Showing Fitting Shop, 208 ft. x 25 ft., built by James Watt and still in occupation.

The reason for Watt's inventing and adopting the "sun and planet wheels" seems made clear in some of the letters. It appears that Watt invented the (now) common crank mechanism for transforming reciprocating into rotary motion. As has often happened, however, some one else learned of Watt's invention and immediately had it patented. An enormous price was then asked of Watt & Boulton for the grant to use the device on their engines. The price was prohibitory, so Watt invented the sun and planet gears by means of which each double stroke of the piston, acting through a beam and connecting rod to the lower end of which one of the gears is rigidly attached, gives the main shaft of the engine two revolutions instead of one, as is obtained with the ordinary crank, connecting rod and beam. It might be added that the second gear is on the main shaft of the engine. Both gears are of the same diameter. A link or arm, much resembling a crank, but free to rotate about the main shaft, holds the connecting rod gear into mesh with the main shaft gear.

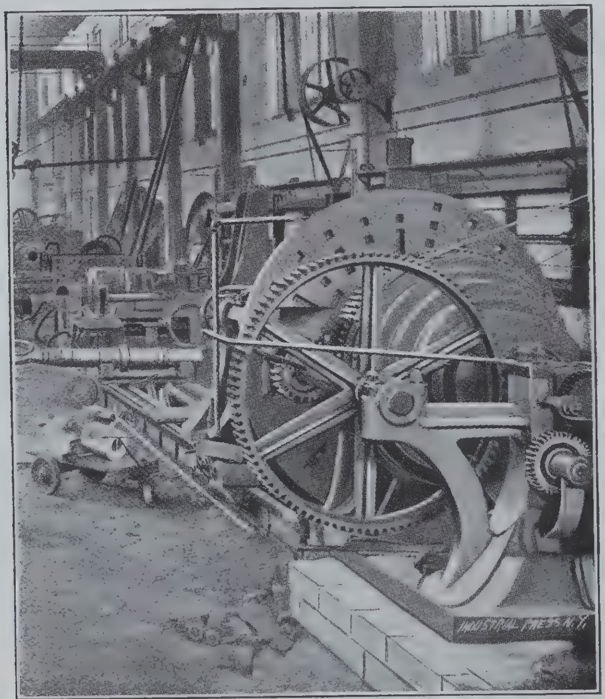


Fig. 10. James Watt & Co. The present Erecting Bay. A Wall Planer shown back of the Lathe was erected by James Watt.

It seems certain that the sun and planet gears were not adopted by Watt & Boulton for mechanical reasons, but for monetary ones with possibly a touch of feeling against the patentee of the crank mechanism.

In a letter by Boulton to Watt he inquires whether his understanding of the use of the flywheel is correct. He then sets forth for Watt's perusal an example of how to determine the size of "fly" required for an engine. He first assumes that a man can do a certain amount of work in lifting coal from a mine by means of a windlass—so many pounds an hour lifted a certain height. Then, that if several men work at the same rate to speed up a "fly," putting a given number of man-minutes work into doing it, it will take an equivalent number of man-seconds work resisting the "fly" to stop it. He gives the final result in the words, "then it will take 32 men one second to stop the fly."

In another letter to Watt, written just after an audience with the King and Queen for the purpose of demonstrating the operation of a letter-copying press invented by Watt, Boulton explains how he found their majesties taking coffee at 5 o'clock, was very graciously received, and kept at full conversation till half past seven. During this time he "made a very good copy of a letter written on a large sheet of paper." The King knew very well about Watt and his works and made many inquiries regarding him, despite the fact that Watt had insisted the King knew nothing of him. Boulton further tells Watt that he gave them both a very fine description of him and his works.

Models of the letter-copying press are in the rooms. They are of the roller-platen type. A felt-covered plate passes under the roll which exerts a pressure. The letter and impression paper are placed on the plate so that the pressure makes the copy. It seems that Watt was the inventor of the letter-copying process and of the ink used for the purpose.

A framed copy of "letters patent" hangs on the wall. The great seal of England is attached by a thong and suspended below. It is a piece of wax 5⅝ inches in diameter and about ¾ of an inch thick and the color of beeswax.

Forrest R. Jones.

Oxford, England.

* * *

Thomas Jefferson, the father of the American Patent Office, is said to have given personal attention to every application made for a patent during the years between 1790 and 1793.

WORK IN THE NEW MACHINE SHOP OF WM. CRAMP & SONS CO., PHILADELPHIA.

About two years ago Wm. Cramp & Sons Co., Philadelphia, completed a new machine shop directly across the street from the shipyard on the water front. A recent visit disclosed a very well-equipped shop for the building of marine engines, it being a decided and agreeable contrast to the old machine shops in the shipyard.

The new shop is a large building of brick with a three-gabled roof facing the street. The erecting floor occupies the middle section, and the machine tools are on the sides of the main floor under the galleries. The traveling crane runway over the erecting floor is well up in the roof, giving a clearance of perhaps 60 feet beneath the hooks. The south side of the building has one gallery over the main floor, and the north side has two gallery floors, which, of course, makes this side one story higher than the main section. Stairways are provided at all four corners leading up to the galleries, and four freight elevators, one at each corner. The tool rooms are in the galleries, there being one on each of the gallery floors. Lavatories and closets are provided on all three floors. Beside the traveling cranes over the erecting floor there are traveling cranes beneath both galleries. A bay is built out from the south gallery floor so that large heavy parts may be moved out over the erecting floor where the traveling crane can handle them. This makes the transfer of large parts, between the two floors, that cannot be handled on the freight elevators easy and convenient. The lighting is excellent, and is all that could be desired for machine shop purposes. The Sturtevant system of forced hot air circulation is employed for heating.

The section under the south gallery is given over to heavy machine tools. Here are a heavy 125-inch crankshaft lathe, a large planer for machining engine frames and bed plates, and three large horizontal drilling, milling and boring machines. All the large tools are driven by independent electric motors, but the smaller tools are motor-driven in groups, the lineshaft being divided into, say, three sections in the length of the shop.

At the time of the writer's visit one of the horizontal drilling machines was employed in boring the bolt holes in the flanges of an intermediate shaft for the battleship *New York*. This is a modest chunk of nickel steel, say, 30 feet long and 18 or 20 inches in diameter. The flanges were about 3 feet in diameter, and each one has eight holes for the coupling bolts. The boring was accomplished by first drilling 1½-inch holes and then enlarging them to the required diameter, which was 4¾ inches at the large end, by means of counterbores. The coupling bolts are made with a quick taper and have no heads. The holes were roughly tapered by using three diameters of counterbores through one flange so that the reaming would be somewhat facilitated. The reaming is not done until the shafts are in place on the vessel, where it is done by hand. This means a lot of hard work for three men at the end of a long reamer handle. About ¼ to 5-16-inch stock is allowed to be reamed out.

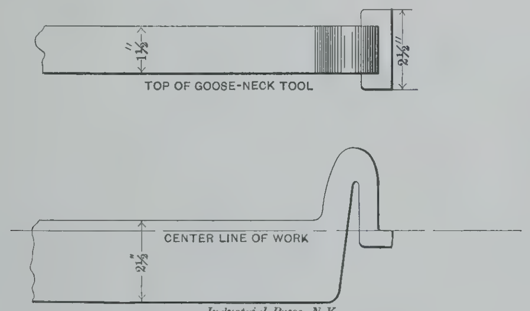


Fig. 1. Tool used in Finishing Nickel Steel Tail Shaft.

A nickel steel tailshaft was being finished in a lathe at the time. The finishing cut was taken with a goose-neck tool like that shown in Fig. 1 while deluged with a mixture of turpentine and lard oil.

Marine propellers are usually fitted to their tailshafts by being bored with a tapered hole through the hub and fitted to the tapered end of the tailshaft. Two keys and a large nut on the end of the shaft secure the two parts together. In some cases the keyways are planed parallel with the axis of the shaft. This, of course, makes the keyways deep at one end and shallow at the other. In the Cramp shops a Morton draw-cut shaper has been rigged to plane the keyways parallel with the taper. The shafts are leveled in front of the shaper and the keyways cut from the top. To make the cut parallel with the taper the shaper is mounted on tapered blocks which tilt it backward to the required degree. It may be asked why the shafts are not inclined to the required pitch. Since the tailshafts are about 50 feet long the end away from the machine would have to be depressed 5 or 6 feet, which would require that a hole be dug in the floor or that the shaper be elevated 3 or 4 feet.

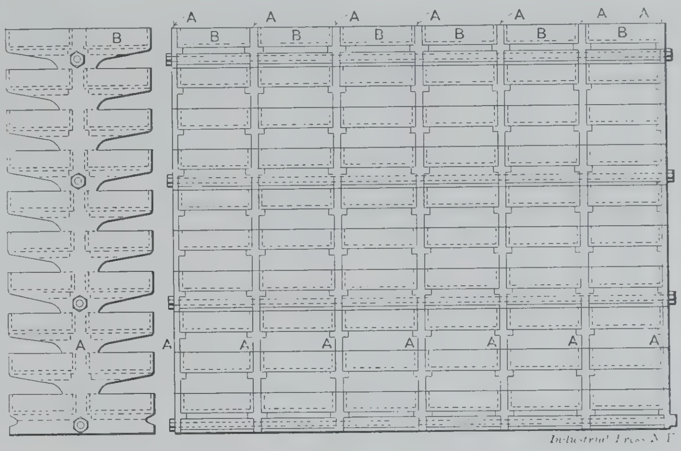


Fig. 2. Tool Room Rack for Trays.

Compressed air is piped to all parts of the shop, and is extensively used for various purposes. On the platen of the large Niles planer was the cast steel bedplate for the engines of a battleship being planed for the feet of the housings. At the same time a workman with a pneumatic hammer was riding back and forth on the platen chipping off the fins and scabs of the casting. Another use of a different character to which compressed air may be put was observed, and that is the cleaning of machines. A compressed air blast is effective in cleaning the dirt and chips from the table of a machine. It leaves the surface practically free from oil and may be used profitably on the frames and other parts that are ordinarily wiped with waste. One bad feature of the practice is that it is likely to cover surrounding objects with grease spattering, unless carefully done.

The tool rooms are provided with racks for trays, on the plan of that shown in end and side views by Fig. 2. They are made of castings like those shown at *A*. These castings are held together by bolts and sections of pipe to act as distance pieces. Ledges cast on the sides support the trays which are made of galvanized sheet iron about 12 inches square and 1½ inches deep. Several racks made on this plan were seen having 13 trays in height on each side and 12 in length, making 312 trays in each rack. The trays are used to hold bolts, screws, rivets, nuts and other small supplies and tools. Being made of iron they do not become oil-soaked as is the case with wood.

* * *

When we speak of the manufacture of iron bolts, nails, rivets, etc., in these days we naturally think that all such work is done, in this country at least, by improved machinery having a large daily productive capacity. Consequently it was with considerable surprise that a shop was recently discovered in Philadelphia, on North 22d Street, working full blast manufacturing carriage bolts and using machinery of the most primitive character, part of which was operated by foot power. The work in progress was forging or upsetting the heads of, say, ⅜-inch bolts. In the machines operated by foot power the hammer was raised after each stroke by a large wooden spring pole attached to the floor overhead. The power-driven machines were of about the same type, the wooden spring pole also being in evidence. The construction of all the machines was of the crudest description and gave evidence of great age. The scene presented seemed quite out of keeping with the present age, it undoubtedly being about as such work was done fifty or sixty years ago.

THE METRIC SYSTEM.

A SUMMARY OF OPINIONS GATHERED BY THE FRANKLIN INSTITUTE, PHILADELPHIA.

While the bill favoring the adoption of the metric system by the various departments of the government was pending before the last session of Congress, a special committee of the Franklin Institute, Philadelphia, had the same subject under consideration. The report of the committee was favorable to the adoption of the system and was as follows:

WHEREAS, It is desirable to obtain an international standard of weights and measures, also to simplify and regulate some of our existing standards; and

WHEREAS, The metric system is commendable not only as a suitable international standard, but also for facility of computation, convenience in memorizing and simplicity of enumeration;

Resolved, That the Franklin Institute approves of any movement which will promote the universal introduction of the metric system with the least confusion and expense.

Resolved, That the National Government should enact such laws as will ensure the adoption of the metric system of weights and measures as the sole standard in its various Departments as rapidly as may be consistent with the public service.

Supplementing the work of the committee the secretary addressed a number of letters to members of the Institute and to others whose opinion on the subject it was thought desirable to obtain. These letters have been published in the last four numbers of the *Journal of the Franklin Institute* and brief extracts from most of them are published herewith, together with quotations from the address of Mr. James Christie, chairman of the committee on the metric system, at the meeting when the subject was discussed; of Mr. George M. Bond, of the Pratt & Whitney Co.; and of Mr. S. M. Vauclain at the same meeting.

In Favor of the System.

In my opinion we need the system and I hope it will become international. We need it because it is the rational system connecting measures of length with those of area, volume, etc. It appears to me that our people have been long enough under the incubus of "long" and "short" tons, "long" and "short" hundredweights, "dry" quarts, "liquid" quarts and the like—units without any rational relation or often with curious fractional relationship to one another.

I may add that I have been in consultation with most of the heads of departments and engineers of the General Electric Co., and find that on the whole they are favorable to the adoption of the metric system, especially on new work, with the idea that it would eventually entirely displace existing measures.—Elihu Thompson (General Electric Co.)

The practical convenience of the workshop must, I believe, give way to the overwhelming theoretical advantages of the metric system. These advantages cannot be successfully disputed, and I have therefore been compelled reluctantly to admit the adoption of the metric system as a wise step for this country to take. Any system is better than none at all, and no system founded on the natural subdivision by 2 would with our present notation be acceptable to the great army of thinkers who plan the work of the world.—Wilfred Lewis.

I have for many years worked with both systems and by practical experience have found the metric system as far superior to our present system (or rather, want of system) as our decimal currency is in advance of the English £, s., d.

When a generation or two hence the history of the present time is written, one of the things that will seem most incredible will be that a nation as far advanced in civilization as the United States is supposed to be, should be weighing its copper by one standard, its silver by another, its diamonds by a third, and its medicines by a fourth, all of them interchangeable only by means of fractions; and measuring its wines by one system, its grain by another and its gas by a third.—Theo. D. Rand.

We consider it of the utmost importance that the inevitable change to the metric system be inaugurated at as early a date as possible. The advantages to be derived from the metric system's adoption are clearly manifest, and opposition to a movement of this kind would seem futile, as, at best, it can only mean a trifling postponement and not, in any way, prevent its ultimate adoption.—The Link-Belt Engineering Co. (J. M. Dodge.)

For more than thirty years we have employed the metric system of linear measurement as being greatly superior for the minute measurements required in the manufacture of watches. In adopting this system we took a centimeter as our unit. This we subdivide into a thousand parts, and have special gages reading to thousandths. In many instances the graduations on our gages we subdivide by the eye. Having this system in use for measurement of watch parts, we also use it in our machine department in the manufacture of machines, and while it is somewhat novel to men when they first come to us, yet they very readily acquire the system, which is extremely simple in computation.—American Waltham Watch Co. (E. A. Marsh.)

We have used the system in our workshop for a number of years, as its units are much more convenient, especially in the fine measurements required in our class of work. We have also published our catalogues of scientific apparatus wholly in the metric system for a number of years, and find that this departure is very much appreciated by the scientific men with whom we deal.—Baush & Lomb Optical Co.

The comparison between the metric system and our system is about equal to dollars and cents as compared with shillings and pence, and I approve any movement which will promote the universal introduction of the metric system, to take effect in the shortest possible time and that will create the least confusion and expense.—Joseph T. Richards, engineer, M. W. (Penn. R. R.)

It would be most satisfactory to have the National Government make the metric system the only legal system throughout the United States, provided sufficient time, say, five or ten years, were given before it became compulsory, so as to permit the different trades to adjust themselves to it.—R. D. Wood & Co.

To argue the superiority of the metric over what we may well blush to admit is still the British and the American system would be a reflection upon the intelligence of the members of the Institute. To my mind the only serious reason for hesitation in pushing the adoption of the metric system is that which, at first sight, appears to be its chief merit, viz., its decimal basis.

The number 10 came to us as a basis of notation through our having each 10 fingers (including thumbs). Its unfitness for the purpose becomes manifest whenever we have occasion to think of the half of a quarter dollar and realize that this half is 12½ cents, bringing us at once into inconvenient fractions. As my good friend, Mr. Benjamin Smith Lyman says, in his paper entitled "Against Adopting the Metric System": "If our early predecessors, in learning to reckon, had but omitted to count their thumbs * * * they would have saved the world a vast deal of labor, and would almost have abolished the use of vulgar fractions."—John C. Trautwine, Jr.

I doubt whether any discussion is needed of the broad subject whether a common system of weights and measures is desirable. That, I think, will be admitted by everyone. Forty years ago the question whether the British system or metric system would ultimately prevail may have been open to discussion. Now the progress of the latter, its adoption by Germany and by Norway and Sweden, its extension in Mexico and South America, its adoption by all scientific men in the researches from which results nearly all human progress have settled that question.

It is not a new thing to change weights and measures. Aside from the recent example set by other nations in the radical adoption of the metric system the English weights and measures have continually undergone change, though the names may have been retained.

The question may be raised, as it always has been, whether the time is opportune for the change. To this the answer seems to be that the difficulties are more apt to increase than to decrease with the lapse of time.—O. H. Tittman (Coast and Geodetic Survey.)

The subject seems to me hardly to require or to permit any extended discussion. It has been familiar to the world, as a question of importance in economics and the industries, in science and in art, for a century, and the system has become general all over Europe and throughout the world, except in the United States, Great Britain and their colonies. In some cases it is used in these countries, and in others generally in their dependencies. The advantages and relative disadvantages of its adoption are perfectly well understood, and have been illustrated by every nation which has accepted it. No nation now enjoying its advantages could be induced to exchange it for our heterogeneous "system" of weights and measures—our no system, rather—and the testimony in its favor from those who have had experience and are best entitled to give trustworthy evidence is practically unanimous. The only voices against either the system itself or its adoption are usually raised where that experience has not been had. It is making progress, slow to be sure, but none the less steady, in our country and in Great Britain. The question is not, after all, on its adoption, but rather regarding the time and the rate of advance toward its installment as a national and officially accepted system.—Robt. H. Thurston.

If called upon to adopt the metric system in any establishment under my control I would make no immediate change in any of the tools, but use them as they are, merely denominating them in the nearest convenient metric unit. For example, call an inch 25 millimeters, and so on with any multiple or subdivision of the inch. It would be urged against this that there is no correspondence between the absolute and nominal dimensions of the tool. This, although very desirable, is not absolutely essential; in fact, in many of our tools, the dimensions are only nominal and not exactly real. It would be desirable, however, to begin to make new gages and tools to replace the old ones as they were worn out. These could be made of actual dimensions to correspond closely with the nominal. The consequence would be that workshops would have for a period two standards, the old and the new; the old applying to all existing products and designs, and the new tools to be applied to new designs and products. The former would gradually disappear and the latter would in time entirely take their place. The manufacturer simply would maintain a double standard—all named in metric units—the one gradually disappearing to be replaced eventually and entirely by the new standard.

The subject of screw threads is frequently quoted and the difficulty and confusion that would result if we were to attempt to change our present system. I may ask, in reply, why change it at all? If it is good, retain it as it is indefinitely.—James Christie.

If we were to go to Germany—any one of us—to start a workshop we would not undertake to start it on an English-speaking basis; we would learn the German language, and we would do our business in German. Now, if we are going to adopt the metric system, all we will have to do will be to learn to think in the metric system. I have known men who have been able to master enough of the German language in three weeks to get along splendidly in Germany. How is this done? Simply by the professor compelling the person to stop thinking in his own language and to think in the language he is going to adopt. When he is compelled to think in that language, it is a very easy matter to teach him to speak in that language; and therefore, instead of making our articles four or three feet long, we would make them a meter long, or a meter and a half long; everything that we would make we would think about in accordance with metric sizes and metric dimensions.—S. M. Vauclain (Baldwin Locomotive Works.)

Opposed to Metric System.

The disadvantage of the French metric system is, that it is an attempt to measure time, space and matter decimally, whereas the decimal system is only specially adapted for computing numbers.

Assuming the advantages of the metric system for purposes of computation, and as the length of the French meter is not a necessary part of the system, would it not be desirable to adopt a metric system for this country with a length for the meter of 40 inches, whereby 25 millimeters would exactly equal 1 inch, with measures of weight and capacity based on this meter as in the French system, so that the system could be used decimally or by whole numbers and fractions as in our monetary system?

Would any advantages claimed for the metric system compensate us for abandoning the standard inch and our fractional and decimal divisions of it, with our engineering literature based thereon?—Wm. Sellers.

The writer was at one time connected with an establishment wherein the metric system was employed in one department and the English system in the rest of the works. It was his experience that foreigners who were used to the metric system, after learning our system, preferred to work with it than with the metric in making drawings; in other words, preferred to work in the department using our present system, rather than in the department where they used the metric.

The writer spent some time abroad a few years ago, and found that for convenience, they used as few decimals as possible upon their drawings, as it was difficult in many places to find room for the figures, just as we try to avoid fractions containing too many figures for convenient insertion.—Southwark Foundry and Machine Co. (Jas. C. Brooks.)

Decimal subdivision may facilitate computation on paper, especially in adding up many digits, but reckoning in the head is much more easily effected with a subdivision by halves or thirds. That is clearly the reason why such fractions are in constant use in the stock market, even with our much vaunted decimal currency established more than a century ago. In a multitude of cases, too, it is easier to make a computation with those easy fractions than to undertake it with the more cumbersome tenths, hundredths and thousandths. Plainly, the mental computations are by far more frequent than ciphering, and would be still more so were we not somewhat tied down to the pencil by the decimal system, as the Chinaman is to his abacus.—Benj. Smith Lyman.

In the absence of convincing argument to the contrary, we would feel, first, that the metric system in itself is not a better system than the English for the purposes of engineering trade; and secondly, even granting its merit, we question whether any such enactments of the National Government would accomplish the desired ends. We believe the American people are too much wedded to the English system to give it up because of any national legislation.—Brown and Sharpe Mfg. Co. (Henry D. Sharpe.)

In answer to question 3, (Have any valid objections against the metric system been urged excepting that the numeration cannot be continuously subdivided by two?), I would say that there are many more valid objections than the one presented in that question. The meter is too large as a unit and a millimeter is too small for uses in the average manufacturing process. The use of the decimal point on drawings and the use of dimensions expressed in decimals is exceedingly inconvenient. The scale of drawings using the metric system is much less convenient than the scales which are derivable from our present units. If it were not the case that some people thought the change desirable, it would be without meaning to have the National Government enter the thin edge of the wedge. There is much productive business in the country bearing no relation to the general government, and those establishments which supplied both the government and general public would be put to the expense of carrying everything in double standard.—F. R. Hutton, Prof. M. E., Columbia University.

The ones particularly affected are the manufacturers, whose standards are all prepared under the duodecimal system; any change to a decimal system would mean to such manufacturers a very great confusion for a number of years, and while I am sure every one would be pleased if all our measures were under the metric system, it becomes a financial question rather than a theoretical one.—New York Shipbuilding Co. (Henry G. Morse.)

In this connection I desire to call the attention of the members of the Institute to an interview I had in 1884 in England with Sir Joseph Whitworth, who, as you are aware, was noted for his improvements in the design of machine tools and the preparation of standard gages, etc. (He at that time was in feeble health, and in point of fact was called from this life a short time afterward.) He raised the question of the futility of asking foreign nations to adopt the standard of England even with improvements as to the simplification of the units of measurement and weight, but he urged that I should use my influence to have the United States in the first place adopt the meter of 40 inches in place of that now represented by a rod of platinum in the archives at Paris, measuring 39.371, approximately. This change would add only ⅝ of an inch to the length of the French meter, and this would appear less in its subdivision, but it would result in an exact correlation between the English unit and its multiple and the metric system. As the comparison now exists, we have the anomaly of assuming 25.3995 millimeters to be equal to 1 inch, while if the change suggested by Whitworth were made, our unit would be 25 millimeters exactly; 100 millimeters (1 decimeter) would be 4 inches exactly; 300 millimeters would equal 1 foot, and 900 millimeters would be 1 yard. The difference of weight that would result from the cubing of these dimensions, or any portion of them, and their contents in the weight of distilled water at a certain temperature, would be insignificant. Already by Act of Congress it has been determined that for postoffice uses, 15 grams French weight shall be taken as equivalent to ½ ounce, although the weight of 15 grams is slightly more than the weight of the ½ ounce of the postoffice measurement.

A tailor in France or Germany or any other country where the French metric system is legalized has a tape-measure divided into centimeters and half centimeters, precisely as a tailor in America has a tape-measure divided into inches, halves and quarters. The finest measurement they have occasion to use is respectively ¼ of an inch in America, and 5 millimeters or approximately 1-5 inch in France or Germany. The division of material bought and sold by weight into halves and quarters, is natural to the human mind. Its division into fifths or tenths is not conceivable. What is possible in money is not practicable in the market. Half of the kilogram, nearly the equivalent of the pound, had to be legalized in France and Germany, and this again is subdivided into quarters, and not into ten parts, in such materials as meat and butter.—Coleman Sellers.

The government is a large buyer of many kinds of manufactured products, and, in order to buy at reasonable rates, must buy what the market supplies; that is, must use what other purchasers require. For example, we have certain standard sizes of pipes and fittings threaded with so many turns per inch; these are well recognized, and we are able to buy pipe of one man and valves or other fittings of another man with reasonable certainty that they will fit one another, and many expensive tools and gages are required to produce this degree of uniformity. Is it intended to forbid the government to buy such pipe and fittings and require it to have made special pipes in millimeter sizes with threads in millimeter pitches? It is hardly conceivable that any one understanding the subject should recommend such a course.

The case is the same with our convenient series of bar sizes, our sheet and wire gages, our bolts, nuts and screws and many other commercial standards in all branches of business. It is true that these conventional sizes are perhaps more or less crude and imperfect; but they are well understood and serve their purpose, and experience has shown how difficult it is to change them when better series have been suggested. It is said that we need not change any actual sizes, but simply call them by new names. For years we have been trying to increase the accuracy of the sizes of things—to have the inch bar or the inch bolt measure 1 inch in diameter and not more or less; but if we must call our 1-inch bar a 25-millimeter bar, which it is not, it seems to me we are retrograding instead of progressing.—C. Sellers, Jr. (Wm. Sellers & Co., Inc.)

Were we to pass upon the simple question of the advisability of having a uniform standard throughout the civilized world, and without regard to the inconvenience and expense incidental to the change, we would decide in the affirmative. We would also be an advocate of adopting the metric system on account of its being more universally used than any one system, rather than to attempt to force the British standards, even though considered as convenient.

In a general way we are in favor of a common system of weights and measures, and the system should be the metric. On the other hand, considering the matter in connection with our own manufacture, or, to make it more definite, we do not believe the time is opportune for adopting this system, as it would lead to considerable expense if it were carried out to a degree that would make it an international benefit. We could readily, and without much expense, express dimensions of tools, fixtures, etc., in metric symbols, but would this be any real advantage unless the pieces so expressed were exact duplicates of similar pieces in use by countries whose standard is the metric system?—Bement Miles & Co. (W. J. Hagman.)

The millimeter is too small for the purposes of the workshop, in that it has to be multiplied many times if decimals are to be avoided and if all the other subdivisions of the meter are to be avoided. If the meter is the unit, then, of course, the decimal point would have to be used.

The Navy Department has, as we all know, adopted the Franklin Institute or Sellers thread for bolts and nuts. That system enters into all construction by the Navy Department and has been used for a great many years. It was on the recommendation of the Franklin Institute that this thread was adopted by the department, and the change to the metric system for the Navy Department in that one item alone would be a serious matter. It would be almost impossible to make the change in even units so as to make the work as interchangeable as it is now required. The railroads, also, have adopted the United States standard thread, and it is now in use on every railroad of the country. These standards are all in English measure, and the pitches are English; so that there would have to be a translation, which means a good deal of trouble and expense.—George M. Bond.

* * *

GEAR CUTTER ATTACHMENT FOR CUTTING INTERNAL GEARS.

From time to time we have described some of the interesting tools and devices devised by different members of the Arthur Co., New York, and again have an opportunity to present one to Machinery readers. The present instance is a gear cutting machine attachment designed by Mr. John F. Arthur for cutting internal gears. The firm of which Mr. Arthur is secretary, make a specialty of gear cutting and have designed and built a number of interesting gear-cutting machines for spur and spiral gear cutting. So the device illustrated in the accompanying cuts, is in line with their regular work.

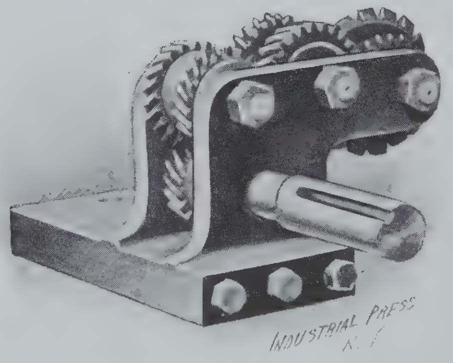


Fig. 1. Internal Gear Cutting Attachment with good Features of Design.

The attachment for cutting internal gears, is shown in Figs. 1, 2 and 3, the first view being made from a photograph and the others from the working drawings, to show the construction. The device consists of a cast iron frame made in two parts which carries four spool gears for transmitting motion from the machine spindle to the cutter. Fig. 1 shows that these gears are right- and left-hand spirals. They are made in this way, of course, to get the smooth driving action characteristic of spiral gearing, and to avoid the end thrust that accompanies single spirals. The gears are alternately steel and bronze; that is, gears *E* and *C*, Fig. 3, are bronze and gears *D* and *A* are steel. The steel gears turn on bronze bolts and the bronze gear *C* turns on a steel bolt. The reason for this is to have both the gears and their bearings in contact with different metals in order to get the best wearing results. This of course does not apply to the bearing of gear *E* as it was necessarily mounted on the driving arbor attached to the machine spindle.

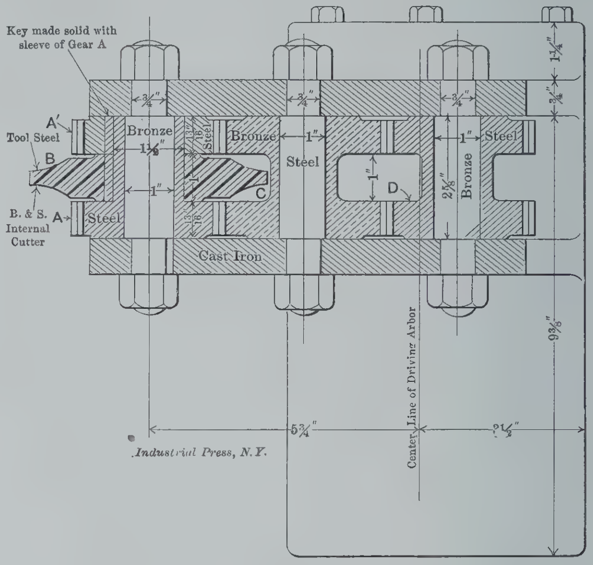


Fig. 2.

Gear *A* is made in two parts designated *A* and *A′* in Fig. 2. A portion of *A* is turned to a sleeve of smaller diameter to form a seat for the cutter *B* and the gear *A′* The end thrust of *A* and *A′*, when driving the cutter in the proper direction, is toward the cutter, thus tending to hold them solidly against the cutter. The advantage of this is obvious since if the spirals were reversed the thrust would be outward which would necessitate a fastening device to hold them to the cutter. Otherwise the thrust would force the gears against the side walls of the frame and cause excessive friction. Another excellent feature of design of this portion of the device, is that the key driving the cutter is integral with the sleeve of *A*, being machined from the solid. We may also call attention to the key, or feather *F*, for transmitting motion from the arbor to the gear *E*. This is made dovetail form and tightly fitted in *E*. The sides of the feather are made radial in the arbor. This type of driving feather has been used for a number of years by the Arthur Co. in their various machine tools. The good features of this form of construction were commented on in the June, 1902, issue in connection with "Some Features of Rolling Mill and Engine Design."

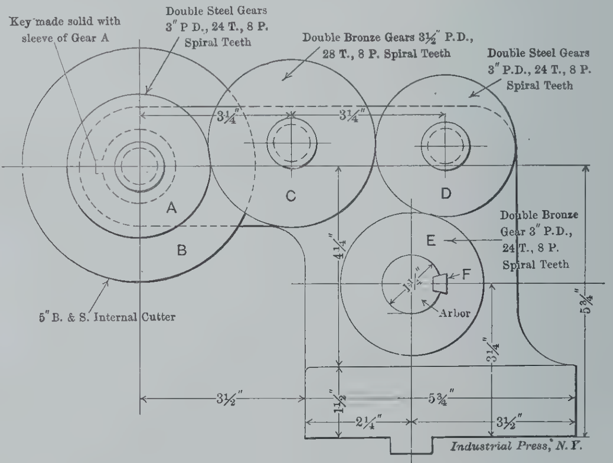
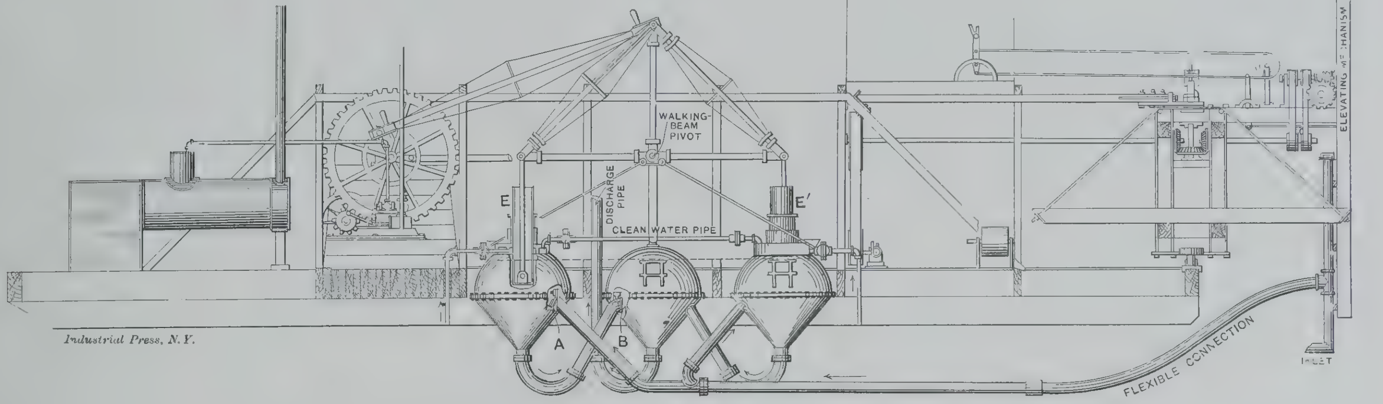

Key made solid with sleeve of Gear A
Double Steel Gears 3″ P D., 24 T., 8 P. Spiral Teeth
Double Bronze Gears 3½″ P.D., 28 T., 8 P. Spiral Teeth
Double Steel Gears 3″ P.D., 24 T., 8 P. Spiral Teeth
3¼″
3¼″
A
B
C
D
E
F
Double Bronze Gear 3″ P.D., 24 T., 8 P. Spiral Teeth
Arbor
1¼″
4¼″
5¾″
3¼″
5″ B. & S. Internal Cutter
3½″
1½″
5¾″
2¼″
3½″
Industrial Press, N.Y.

Fig. 3.

Special B. & S. cutters, 5 inches in diameter, are used on the attachment. The extreme width of internal tooth that can be cut is 3½ inches.

RECLAIMING GOLD FROM THE BEDS OF RIVERS —NOVEL GOLD DREDGING MACHINE.

Prof. Shaler, the noted geologist of Harvard University, declared a year or so ago that he believed the total production of gold throughout the world would eventually be greater than that of silver. He pointed out that while silver is obtained in large quantities, it is only gained by expensive mining operations, so that the price per ounce must always cover a relatively large labor cost. In the case of gold, however, there are possibilities of obtaining great quantities at a comparatively low labor cost by river and ocean dredging. There are great deposits of gold-bearing sands at the mouths of all great rivers draining gold-producing area such as, for instance, the Sacramento in California and the Yukon in Alaska. These gold-bearing deposits could be handled in immense quantities if the proper dredging machinery was provided, and at very low expense. Professor Shaler predicted that dredging machines would be so perfected that the lifting and separating of the precious metal from the ocean deposits would cost so little in proportion to the amount of gold recovered that it would become a most profitable and productive industry, since it is one that would only be limited by the number of machines at work, the supply of gold-bearing sands being practically inexhaustible.



The Bewsher Dredging Machine for Operating in the Gold Bearing Deposits in the Mouths of Rivers.

The production of gold by the present methods on land is an enormously wasteful occupation, considering all the miners and prospectors engaged in it and the total return. It has been estimated by competent authority that every dollar's worth of gold in circulation at the present time has cost a day's labor or more in the aggregate. Some men have won great prizes, but many have gained nothing and perhaps lost their lives in the search. The gold-dredging machine when perfected after the conception of Professor Shaler would make a fixed daily production almost an absolute certainty.

A novel machine for gold-dredging is illustrated herewith, known as the Bewsher dredging pump, which will be found somewhat interesting on account of certain mechanical features. One of these is that the pumps are in effect mechanical pulsometers. That is, they can handle muddy, gritty water or even water carrying large pebbles without damage to the working parts, the same as the steam pulsometer, but at a much higher efficiency in the matter of steam consumption. This machine is designed for river dredging, where the gold bearing deposits may be discharged on land and there passed through sluice boxes. For ocean work it would, of course, be necessary to have all the apparatus on board and to have the dredge a much stronger and more seaworthy vessel.

The pumps *E E′* are attached to opposite ends of a walking-beam which is operated by a 20 H. P. steam engine. As a plunger rises the water from the ocean or river bottom flows through the 8-inch inlet pipe into the large receiving chambers and at such velocity that the mud and pebbles are lifted bodily, carrying the gold nuggets and fine gold with it. Twelve cubic yards are handled per minute, which means a velocity (17 feet per second) sufficient to carry 25 per cent of granular matter in suspension or three cubic yards per minute. To prevent the grit getting on the plungers and cutting the wearing surfaces a spray of clean water is constantly injected around the plungers just beneath the stuffing-boxes. Clack valves are provided with leather hinges to act as checks. These hang in a perpendicular position, which reduces to a minimum the possibility of sand and pebbles preventing their seating properly. The advantage of sucking the deposits from the bed instead of lifting them mechanically, as with a bucket dredge, is that it causes only a local disturbance at the mouth of the inlet pipe. A bucket dredge, on the other hand, disturbs a large area of the bottom and constantly tends to cause the gold to sink lower and lower, where it finally becomes out of reach. Gold has a specific gravity of about 19.3, so it always seeks the lowest levels, tending all the while to lodge in cavities and crevices where it cannot be recovered except by a powerful suction. The general appearance of the machine shown is crude, and the design, aside from the central idea, is not attractive, but it appears, nevertheless, to have possibilities that may make Professor Shaler's prophecy come true before long.

* * *

RAPID WORK WITH STEAM SHOVELS.

Probably the most interesting steam shovels in the world are to be found on the "Mesabi Range," one of the five districts which go to make the Lake Superior mining region. Here they render possible in its present scale of magnitude the so-called "open-pit" mining, the shoveling of iron ore directly from its natural resting place in the earth to the railroad cars which are to carry it to market. An "open-pit" mine is nothing more nor less than an immense hole in the ground, perhaps half a mile square. Into this railroad sidings are run, as they might be into a vast stone quarry, and in some of these mines, where fully a million tons of ore are taken out each year, there are in operation simultaneously anywhere from half a dozen to a dozen of the large shovels.

Remarkable records of rapid loading are made by these shovels. As a rule five trips of the dipper are required to fill an ordinary freight car, but so rapidly is the long arm raised and lowered that it is accounted slow work if more than five minutes be consumed in loading a car, and not infrequently cars are fully loaded and pushed out of the way of the shovel at the rate of one every two minutes. From eight to a dozen men are required to operate a shovel of fair capacity, and by steady work they can place fully 7,000 tons of ore aboard the cars in a single working day. In order to make such a record as this, however, it is necessary that the men have an opportunity to work on the side of a pit or mine, where it will not often be necessary to resort to blasting to loosen the ore, so that it may slide down to the shovel, and it is further essential that a locomotive be constantly at hand to shift the cars as rapidly as they are filled, thus preventing delay.—*Philadelphia Record.*

* * *

The following wonderfully intelligent note recently appeared in a New York daily:

That it pays to use a smoke-consuming plant has been demonstrated at the New York Post Office. The building was formerly provided with a 6 horse power steam plant that used 24 tons of hard coal a day. This plant was removed and a 12 horse power smoke-consuming plant put in its place, which uses only 18 tons of soft coal a day. Thus double the power is obtained from one-fourth less coal, and, while money is saved, no nuisance is created. This seems to show that a smoke-consuming apparatus will soon pay for itself.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY
Design—Construction—Operation.
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
9-15 MURRAY STREET, NEW YORK CITY.
CHICAGO—1462 MONADNOCK BLOCK. BOSTON—620 ATLANTIC AVE.
PHILADELPHIA—MACHINERY FLOOR, THE BOURSE.

SUBSCRIPTIONS.
SHOP EDITION, $1.00 A YEAR. TEN CENTS A COPY.
ENGINEERING EDITION, $2.00 A YEAR. TWENTY CENTS A COPY.
FOREIGN EDITION, $3.00 A YEAR PREPAID.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

NOVEMBER, 1902.

NET CIRCULATION FOR OCTOBER, 1902,—24,183 COPIES.

The entire Engineering Edition is printed on coated paper, and a data sheet is furnished with every copy—price $2.00 a year. The Shop Edition is printed on super-calendered paper—price $1.00 a year.

THE LIGHT UNDER THE BUSHEL.

A somewhat remarkable example of the policy of secretiveness which some manufacturers are wont to adopt occurred at a recent meeting of the American Electrochemical Society, at Niagara Falls. Of the score or more electrochemical industries in that city only five permitted the delegates to the convention to visit their works. Of these five were, the Carborundum Co., well known to our readers, and the Atmospheric Products Co., to whose remarkable work we referred in our July number.

While we are well aware that there are cases where it is advisable to withhold information about processes and to keep one's methods secret, we believe that more often it is a mistaken idea. Does anyone suppose that the five industrial establishments at Niagara where visitors were admitted will suffer from their open-door policy or lose money or business that might have been retained had "No Admittance" signs been posted there? Or is it probable that those who declined admission will have acquired benefits thereby that will not be shared by their more liberal neighbors? On the contrary, the latter secured some valuable free advertising that will almost certainly bring results at some future time.

We recently visited an establishment, with a view of writing a description of its general practice. A simple method of chucking a piece in the lathe was alluded to by the proprietor with the request that a description of it be left unpublished, as it was, in a sense, a proprietary idea, originated in the development of the business. Of course the request was granted, but in visiting a rival concern in another city a little later, precisely the same process was found to be in use there. This is what might have been expected, for every live, enterprising concern generally has methods which compare favorably with those of competitors, accomplishing substantially the same results and in about the same time; otherwise it would not be able to compete. As a matter of fact it is not possible to keep much information of this character a secret where workmen are employed who are liable to change positions, who talk with workmen in other factories and who travel to a greater or less extent. In these days it is seldom that a firm has a process that is not known or used somewhere else, at least in an equivalent form. People who have advanced to corresponding levels in civilization generally have and do about the same things, whatever their color or place of birth, and many instances could be quoted to show that a similar law holds in the development of industries.

And how is it with the individual workman? Years ago a machinist acquired his information and skill through his own personal experience. It was his stock in trade and he was very reticent about giving away to others what had cost him so many years of hard work to learn. But education has changed all this, and to show how such is the case we are able to quote a very apt sentence from one who is a foremost leader in the practical education of practical men:

In a recent address, President Pritchett, of the Massachusetts Institute of Technology, says: "One of the great advantages of education is the preparation which enables a man to learn from other people, without having to wait to learn, bit by bit, from his own hard experience." The experience of those who have gone before is to be found in books; of those who are working to-day, in the technical papers; and one can acquire many times as much information from these sources as he could obtain without them. He can also gain information by traveling and by observation. There is so vast a store of common knowledge to be had from these sources that, except in very rare instances, a man will gain nothing whatsoever by trying to withhold the little mite he has himself found out. If a man has really become proficient in any line of work let him publish his ideas, tell other people about them, explain his methods, and do as much as he can to teach others the same work. If his methods are found to be good ones his fame will widen, he will be consulted as an authority and will be in demand as a workman. If he does not do this, he may feel reasonably sure that some other person will, and that this other person will be the one who will eventually pull ahead, other things being equal.

* * *

THE ENGINEERING AND SHOP EDITIONS.

The many expressions of approval that have come to us regarding the engineering edition of MACHINERY indicate that the paper in its new form will meet the needs of a much larger number of readers than ever before. The reason for this is obvious. There is a demand for a publication dealing with the design, construction and operation of machinery, which covers its field in a complete manner. We have long realized that it was not possible to publish a technical periodical at a dollar a year that was as complete as it should be to enable one to keep in touch with mechanical thought and progress, and the two-dollar or Engineering Edition is the result.

Several subscribers to the dollar or Shop Edition have asked us whether, if they change to the Engineering Edition, they will still have all the matter contained in the Shop Edition. In reply, the Engineering Edition contains all the reading matter and advertisements appearing in the Shop Edition, and there are, besides, from 16 to 24 pages of general and current engineering matter. A data sheet containing four 6 x 9 pages of notes, tables, charts, etc., for notebook use also accompanies every number of the Engineering Edition.

In addition to articles upon machine design and general engineering subjects, the extra pages contained in the Engineering Edition have several features that make the paper of great value to a person wishing to keep in touch with mechanical progress without having to take the time necessary to look through a large number of different publications. Among these are: A summary of the leading technical and mechanical events of the month; a digest or summary of the most valuable articles appearing in the other technical papers; and a summary of the most valuable papers presented before the various engineering societies.

As stated above, the price of the Engineering Edition is $2.00 a year, or double that of the regular edition that has heretofore been published, and it will be found more than twice as valuable to the busy technical reader. The Shop Edition corresponding to the regular edition heretofore published is issued at $1.00 a year. Most of the matter of a technical nature upon machine design that has sometimes appeared will now be transferred to the Engineering Edition, giving more room in the Shop Edition for articles upon shop methods.

THE POSSIBILITIES OF LIQUID FUEL.

The great coal strike and resulting coal famine have turned attention to the possibilities of liquid fuel and although many extravagant claims have been made for it, petroleum can unquestionably be used profitably in many sections of the country. News items in the daily and weekly papers from all parts of the country indicate that the scarcity of coal has caused many power users to at least investigate the question of liquid fuel and in numerous instances to install oil-burning apparatus.

The use of petroleum has not increased in the East to so great an extent as might have been expected, largely because there have been no facilities for bringing the Texas oil to Northern cities. Government regulations are such that the coastwise carrying trade must be by American-built ships, and it has been necessary to refit or to build American vessels for this purpose. Shipyards are busy upon such contracts and within the course of a few months it is estimated that 25 tank steamers will be running between Texas ports and Philadelphia, Baltimore and New York.

On the Pacific coast liquid fuel is meeting with success. The California oil fields have yielded so abundant a supply during the past two or three years that the power situation has been materially changed. The high price of coal in California made steam power almost a luxury, compared with some other sections of the country, and as the State has great water resources it has led the country in plants operated by water, with electric transmission. It is stated by the *Engineering News*, however, that at the present time California steam plants using fuel oil at 70 cents per barrel are producing power at a total cost for fuel and labor of only $34.60 per indicated horse power per year of 313 days of 24 hours each. Wherever oil can be readily transported it is exerting a marked influence from one end to the other of the Pacific coast. As far north as the Columbia and Yukon Rivers oil is being considered in place of cordwood, now used, the only obstacle to its adoption being where steamers go within the domain of the Dominion Government, whose laws do not permit the use of oil for passenger boats.

The first steamship to sail from San Francisco using California oil was the Enterprise, and since that time there is said to have been over 50 vessels equipped for service on the Pacific, many of which visit Japanese ports. It not only requires less weight of oil than coal for a given trip, but much less time for taking on a supply of fuel. This was strikingly shown in the case of the steamer Nevadan, which made a trip from New York to Honolulu and return. Part of the way she used coal and it required two days to fill her bunkers. The balance of the trip was made with oil as fuel and 4,500 barrels were stored in her tanks in five hours.

The most interesting event in the use of fuel oil for marine work is the tests lately made on the steamer Mariposa, which sailed between San Francisco and one of the Society Islands. A Government engineer was on board to render a report to his department. While the Bureau of Steam Engineering is not ready to give detailed information with regard to these tests, a few general facts are known. The vessel has a displacement of 3,160 tons and covered a distance of 3,438 miles. The average daily run was 354 knots; the oil consumed daily, 278 barrels—or 3,720 pounds per hour. This was equivalent to 1½ pound of oil per horse power hour or 50 per cent. less than the weight of coal required for similar service. Only 12 out of the 18 furnaces were used and the engine and boiler room force was reduced from 36 to 20 men.

Turning to railroads the Southern Pacific have about 400 of their locomotives equipped with oil burners; the Atchison have one-third of their locomotives refitted and several roads are using oil to a less extent, as for example the Boston & Maine for its Hoosac Tunnel service, and the Kansas City Southern Railway.

The advantages claimed for liquid fuel are somewhat as follows: It is easily and cheaply handled, clean, and produces a very efficient fire; furnace doors need not be opened in firing; no ashes to cart away; fire can be easily regulated; increase in steaming of the boiler and reduction in the boiler room force. As opposed to this are the claims that the fire is too intense, injuring the boiler shell, and that the flues become coated with a deposit owing to the fact that perfect combustion is not always secured. In locomotives this coating is removed by the sand blast, sand being thrown into the firebox and carried through the tubes by the powerful draft. In stationary and marine work this method is not available, as a matter of course.

The relative values of coal and oil for fuel depend almost entirely upon the locality. Where the oil can be easily transported and coal cannot, oil has the advantage. Prof. Wm. B. Phillips, of the University of Texas, estimates that from 2½ to 4 barrels of Texas oil are equivalent to one ton of coal, according to the quality of the coal. A pound of the oil will give up from 17,000 to 20,000 B. T. U. as against 13,500 for coal. In Kent's "Steam Boiler Economy" several data are published upon the efficiency of fuel. A test by the Twin City Rapid Transit Co., of Minneapolis and St. Paul, showed that with coal at $3.85 per ton of 2,000 pounds, of a quality that would evaporate 7½ pounds of water per pound of coal; and with Lima oil costing 2¼ cents per gallon, and weighing 6-6/10 pounds per gallon, the two fuels were equally economical. A member of the Engineers' Club of Philadelphia in 1892 stated that 1 pound of anthracite coal evaporated 9.70 pounds water; 1 pound bituminous coal, 10.14; and 1 pound fuel oil, 36 degrees gravity, 16.48. The calorific energy of petroleum was estimated to be 60 per cent. greater than that of bituminous coal, although theoretically petroleum would exceed coal only by about 45 per cent. Other tests could be quoted and instances multiplied to indicate the prominence of petroleum fuel for various kinds of service, but a mere collection of statistics would be of no particular interest. It is evident that people are now more familiar with the advantages and disadvantages of petroleum than before the coal strike, and more will use it than ever before and its use will continue to increase until the demand for it is equal to the supply, which unfortunately will probably become less rather than more in future years.

* * *

LOCOMOTIVE MANUFACTURE IN THE UNITED STATES.

The census bulletin on the manufacture of locomotives in the United States compiled by Edward H. Sanborn, records 2,831 steam, 55 compressed air, 155 electric and 5 gas locomotives built during the census year 1900. There were 28 establishments whose sole or chief product was locomotives. These works turned out 2,774 locomotives, employed 19,039 wage earners and paid them $10,899,614 wages. The value of the locomotives built was $27,121,063. In addition there were 272 locomotives built in 26 railroad shops, making a total of 3,046, having a total value of $30,397,456. The average value of the locomotives built in 1890 was $8,199, while that of the 2,774 built in the locomotive shops in 1900 was $9,777, or an increase of 19.2 per cent. This increase is due in part to changes in size and construction.

It is pointed out that in 1890 a freight car having a carrying capacity of 60,000 pounds, was thought adequate for all ordinary purposes, but in 1900 the limit has been increased to 100,000 pounds, while cars of even greater capacity are being constructed. The increase in size has been made possible by the substitution of steel for wood. The general application of air brakes to freight cars enables freight trains to travel at higher speeds than was possible a few years ago. The increased size of the cars and the higher speeds have made necessary the greater size of locomotives. The important features of this development are larger boilers with thicker shells; larger fireboxes and increased grate area; higher steam pressure; the substitution of steel castings for cast iron or wrought forgings; compounding, etc.

In 1890 the average weight of locomotives built in one plant was 92,000 pounds for the engine alone, exclusive of the tender. In 1900 the average weight of locomotives built in the same establishment, was 129,000 exclusive of the tender. The average weight including the tender was 158,534 pounds, or 79.3 tons. The largest locomotive built weighed about 133 tons, or 190 tons with the tender, and it is not safe to say that this limit will not be exceeded. In 1870 the average steam pressure was 130 pounds; in 1890 it was 160 pounds; and pressures have been increased 25 pounds or even more in the last ten years. Locomotives carrying 225 pounds are frequently built. The average thickness of boiler plate in 1890 was ½ or 9-16 inch for the shells, but now it is quite common to use plates ⅞ inch thick.

Considerable valuable information is given in the bulletin relative to compound locomotives. It says that the principle of compounding is not new, patents for compound locomotives having been issued in the United States as early as 1846. The Shepard Iron Works, Buffalo, N. Y., built a compound engine in 1867.

* * *

NOTES AND COMMENT.

REVIEW OF CURRENT EVENTS, TECHNICAL AND MECHANICAL.

The Massachusetts Institute of Technology, Boston, the largest technical school in the country, has opened this fall with 1,600 students, an increase of nearly 200 over last year. The freshman class numbers over 500. This unusual growth has taken place, moreover, in the face of the establishment of courses in engineering by many of the academic or classical colleges, especially throughout the central West. It is very evident that there is a decided tendency towards technical training.

In the October number of Machinery reference was made to the Kaiser Wilhelm II., which was launched August 12, as "the largest steamer in the world." This claim was, however, but short lived, for at nearly the same time that the Kaiser Wilhelm II. was launched by the North German Lloyd the White Star Line launched, at Belfast, the Cedric, to which the above title now belongs. Though 6½ feet less in length than the Kaiser Wilhelm II., the extra breadth and draft of the Cedric give her a displacement 12,000 tons in excess. The Cedric is practically a sister ship to the Celtic, but exceeds that vessel in displacement by about 1,000 tons. She is 700 feet in length, 75 feet in beam, 49 feet in molded depth, and at her maximum draft of 36½ feet (to which, by the way, she cannot be loaded until the new 40-foot channels are dredged) she will displace about 38,500 tons.

A remarkable plan has been proposed for handling trains on the West Va. Central R. R. In passing through Tucker County it is impossible to maintain more than a single track because of the wildness of the country. In one place the road passes down through a deep gorge and afterwards up a heavy grade connecting Hendricks and Elkins, West Va. The location and grades of this track are very disadvantageous for handling freight in both directions, and it is proposed to use the gorge route only for west-bound trains and to overcome the obstacles in the way of locating an east-bound track elsewhere, by providing an elevator or an immense moving platform for raising a whole train loaded with coal or merchandise to the height of 1,000 feet, up the side of a precipitous slope of the great "backbone mountains." If this is done, electric power will be used, of which there is an abundance in the vicinity.

The late Henry A. Rowland, physicist and mathematician of the Johns Hopkins University, Baltimore, Md., is perhaps best known by his establishment of the mechanical equivalent of heat at 778 B. T. U., now so generally used in calculations. The extent of his scientific work, however, was very remarkable, and he made noteworthy achievements in various directions. Among these was a system of telegraphy called the Rowland Octoplex system, which secures a simultaneous sending of eight telegrams on one wire—that is, four telegrams in one direction and four in the opposite direction. Twenty thousand words an hour can easily be sent, and if emergency requires this may be increased to nearly thirty thousand. The transmitters used resemble typewriters. A complete installation has four keyboard transmitters and four receiving instruments, which print the messages in Roman type. A telegraph line thus equipped has been established between Berlin and Hamburg, Germany, and a second one is now under consideration.

The occasional interviews with Nicola Tesla published in the daily papers represent his schemes as being so visionary that it is often wondered whether he is actually engaged in any substantial work for the advancement of electrical science. His achievements in the development of alternating currents have been so remarkable that it seems incredible that he should be giving his attention to plans considered wholly impracticable by eminent electricians. It will be new to most readers to know that he is actively engaged in laboratory work on a large scale. He has completed a new laboratory at Wardenclyffe, L. I., about 65 miles from New York. This is a large building, and Westinghouse, Church, Kerr & Co. are to supply the power plant equipment. A large steel tower of peculiar construction has been erected in the vicinity, underneath which is a deep pit. The use of this structure can only be conjectured, as Mr. Tesla always prefers to observe great secrecy with regard to his experimental work. It is supposed, however, that the tower is intended for experiments with wireless telegraphy and wireless power transmission, and that the pit is for the purpose of obtaining a more perfect ground connection.

The *Iron Age* says that the rivets through the keel of the seven-masted schooner Thomas W. Lawson, which was launched from the Fore River shipyards a short time ago, were nearly 5 inches in length by 1¼ inch in diameter. It was not possible to upset these properly with an ordinary yoke, one arm of which served as the anvil to resist the blows of the pneumatic hammer carried by the other arm. To have made the anvil heavy enough to accomplish the purpose would have produced a tool extremely awkward and difficult to handle in the cramped quarters underneath the keel. The difficulty was overcome by doing away entirely with the anvil and substituting a second pneumatic hammer. The two hammers, one on the end of each arm of the yoke, worked perfectly and there was no further trouble in making the rivets fill the holes completely. The strokes of the hammers were so exceedingly rapid that it made no difference whether they worked synchronously or not.

The same scheme was tried at the William R. Trigg Co.'s shipbuilding plant at Richmond, Va., with very satisfactory results as we were informed by Mr. William Burlingham some months ago, who has applications filed for patents on the system.

OCEAN TRIAL OF THE SUBMARINE BOAT "FULTON."

The submarine boat Fulton recently made a trial trip from New York to Washington, on the outside, under its own motive power. This is the longest trip ever made by this type of boat on our side of the Atlantic. The intention was for a longer trip, which would no doubt have succeeded but for the rupture of a pipe, due to the accumulation of sulphuric acid fumes around the storage batteries, which terminated the trip until repairs could be made. No serious damage was done to either the boat or the machinery. This trip was the second of a series of trials that are being carried on to demonstrate the value of this type of boat. The first occurred on November 5, 1901, when she was submerged for a period of 15 hours, during a storm, without any inconvenience to the crew.

Six boats of this class are being built by the U. S. Government at a cost of $170,000 each. The Fulton is 63 feet 6 inches long and has a diameter at the largest part of 11 feet 9 inches. For running on the surface a gasoline engine, capable of developing 160 H. P. is used. This is calculated to produce a speed of 7 to 10 knots per hour. Under water the boat is run by electricity furnished by storage batteries. One charge will last six hours and develop 70 H. P. The armament consists of five Whitehead torpedoes which are 11 feet 8 inches long and carry sufficient explosive powder to destroy the largest vessel ever built. Running out behind the boat are two rudders which, when bent down or up, cause the boat to sink or rise. She can dive out of sight in about 15 seconds and may be sunk to a depth of 100 feet.

If these boats do the work for which they are intended, experts say that every naval power must have them and there will be as great a revolution in ships as when sails were superseded by steam power.

ANOTHER INTERURBAN ELECTRIC RAILWAY.

The October 9th number of the *Engineering News* contains an extended account of the recently completed Aurora, Elgin and Chicago third-rail electric line. This is one of several similar lines that have been built or are now being constructed in this country. Now that the alternating system of electrical distribution has become so well adapted to such lines the development of interurban electric railways, even between quite distant points, may be expected to be rapid. The railroad in question has a main line 33 miles long, one branch 16½ miles, and a branch 6 miles long. Twenty-one and one-half miles are double track, and the whole system conforms very closely to ordinary steam railway practice in location and construction. The railway is built entirely on its own right of way, and its construction has involved some heavy cuts and embankments, bridges, etc. The line will be operated by trains instead of single cars, using the multiple unit system, in which each car has its own motive power, but all the motors are controlled from the forward car. The cars are 47 feet 3 inches long, weigh 74,000 pounds and have 125 horse power motors. The wheels are 36 inches diameter.

The power station for the entire line is at Batavia, Ill., and has three 2,200-horse power Cooper-Corliss engines with General Electric generators. An alternating current of 26,000 volts is employed for this distribution. It passes over high-tension cables to substations, located ten miles apart on the line of the railway. In the stations are stationary transformers which reduce the current to 420-volt alternating, from whence it enters rotary transformers that deliver a 600-volt direct current to the third rail, which is used in preference to trolley wires.

THE COMING AUTOMOBILE SHOW.

The automobile show to be held in Madison Square Garden, New York, January 17-24, 1903, promises to be the most successful event of the kind that has yet been held in America. Over one hundred concerns will be represented by machines of their construction, but it should not be assumed that there are that many automobile companies manufacturing automobiles alone. Many of the machines to be exhibited are the work of firms building machines as a side issue. At the automobile show held in New York last November, 92 companies were represented and 150 machines shown.

As an indication of the unsettled condition of the automobile business it may be mentioned that, of the firms taking part in the exhibit of last year, only a few more than one-half will be represented this year, the remainder being new concerns that have sprung into existence in place of those having gone out of business. While the progress of the automobile industry may follow the upward trend of the now defunct bicycle boom, it must necessarily be slower and on more conservative lines. The sudden and tremendous popularity of the bicycle is only equaled by the suddenness of the loss of public interest in it. Only six years ago the greatest of bicycle shows was held in Madison Square Garden, and now we learn that the greatest bicycle concern of all, and the pioneer at that, the Columbia Bicycle Co., has closed its bicycle plant at Hartford, Conn. The growth of the motor-driven vehicle in popular favor, is slower, and it is fair to believe that it will be much more permanent. The ultimate test of the permanency of the automobile will be how well it serves utilitarian purposes, and that it will do this well, there is little doubt. The motor-driven vehicle is destined to become the principal factor in moving freight in city streets, to the exclusion of the horse-drawn dray and truck. As a vehicle of pleasure it has been an instrument of education, demonstrating the possibilities of motor-driven vehicles. It does not matter if these experiments have been carried out to satisfy the whims of wealthy patrons, the results redound to the benefit of everyday commercial interests by making practical machines possible.

* * *

An immense oil "gusher" has been struck at Cotella on the South Alaskan coast. The spouting oil rose nearly 200 feet before it could be capped. It is said that the oil is of good quality and is worth $4 a barrel at the well. About 10 miles of coast line in the Cotella region have been located for oil borings.

CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The annual meeting of the National Machine Tool Builders' Association was held at the Hollenden, Cleveland, Ohio, on October 14 and 15, twenty-eight members being present. The subject of prices was not discussed, most of the time being devoted to perfecting and extending the organization, which was originally formed by the manufacturers of lathes, and later extended to include makers of drills, planers and milling machines; and it is now the intention to invite all machine tool builders to join. A number of trade problems were discussed and a committee appointed to recommend a uniform practice in relation to furnishing attachments and accessories to machine tools. A paper on the introduction of the metric system in this country was read by Mr. F. A. Halsey, covering the results of a month's research on the advantages and disadvantages of the metric system of measurement as applied to the machine tool trade of this country, and showing that the change would result in great confusion and expense which it would be difficult to estimate, and which would extend over many years, without any corresponding advantage.

Mr. Fred. Geier, of the Cincinnati Milling Machine Co., also submitted a statement carefully prepared by Mr. E. M. Chase, the superintendent of that company, showing that the actual loss in changing small tools such as drills, reamers, gages, etc., now used in their work would amount to over $50,000; and this sum includes no allowance for loss of time while the workmen are becoming accustomed to the new measurement.

The change not being simply the alteration of English dimensions into metric, but a complete change to the metric basis, Mr. Geier states that in his opinion the best way to make the change would be to start an entirely new establishment with new tools, drafting room and pattern shop. Keep everything separate from the old establishment until the new is running in good order and then drop out all of the old except that needed to keep up the repairs. This may seem to be an expensive method but when the number of things to be altered is considered it appears in a different light.

In Germany the metric system has been in operation, theoretically, for 29 years, yet the two systems of measurement are still in use, as is also the case in 33 other countries where the system has been started.

The difficulties of the change will be felt most by those establishments manufacturing duplicate work in large quantities by the use of special tools, jigs, etc. Here the change will amount virtually to shutting down and starting again under the new conditions. This would entail a great loss of time for making new tools, new drawings, jigs, etc., and changing over all of the large tools to the new system. In the manufacture of large machinery this matter would, of course, be less serious.

Another objection to the adoption of the metric system is that even after all these years no standards have been adopted by the metric countries for screws, gears, bolts, etc., and an attempt to apply our present standards to metric measurements would lead to cumbersome and impractical dimensions.

Coming to the point of just what must be altered or renewed in changing the system, the case was cited of a factory employing 300 men, engaged in the manufacture of milling machines. The following is a list of the tools that would have to be substituted for those at present in use in the above mentioned factory in order to change from the English to the metric standard:

4,000 twist drills of various sizes, 525 counterbores, 1,008 reamers, 905 mandrels, 1,460 gages, 107 chasing tools, 1,300 taps and hobs, 198 boring bars, 2,000 cutters, 255 screw machine forming tools, 1,008 jigs, 315 special cutters and gang mills.

The estimate value of which, as above mentioned, would be as previously stated, $50,000.

After an informal discussion, a committee consisting of Fred. A. Geier, P. E. Montanus and Fred. Eberhardt, was appointed to draw up a set of resolutions. This committee presented the following resolutions, which were adopted:

Whereas the members of the National Machine Tool Builders' Association, in convention assembled, having carefully considered the provisions of house bill H.R. 2054, do hereby emphatically protest against the enactment of said bill because:

First, The experience of Germany in which the old measures are still in large use has shown that the change cannot be completed even after a generation of confusion.

Second, The sale of many million dollars' worth of machine tools, has been made abroad, by members of this Association, especially to France and Germany, without requirement or request, by the purchasers, for changes in general construction, to conform to metric measurements, the only changes being in adjusting and measuring screws; the great majority of machines needing no changes whatever.

Third, The adoption of the metric system would entail an enormous first cost of new equipment to conform to the new standards, a constant increased cost in the maintenance of a double standard for repairs and renewals, and a consequent increased cost of the product to the consumer.

The formation of the Association has already resulted in an extended acquaintance among its members, and a better understanding of the various problems which confront the machine tool manufacturer; and with the increase in membership it is confidently expected that its field of usefulness will be enlarged.

The following firms were represented at the meeting:

C. H. Alvord, Hendey Machine Co., Torrington, Conn.
B. F. Barnes, B. F. Barnes Co., Rockford, Ill.
F. W. Boye, Schumacher & Boye, Cincinnati, O.
W. H. Carpenter, Rahn, Mayer & Carpenter Co., Cincinnati, O.
W. P. Davis, W. P. Davis Machine Co., Rochester, N. Y.
J. B. Doan, American Tool Works Co., Cincinnati, O.
Enoch Earle, P. Blaisdell & Co., Worcester, Mass.
Fred L. Eberhardt, Gould & Eberhardt, Newark, N. J.
Joseph Flather, Flather & Co., Inc., Nashua, N. H.
Philip Fosdick, Fosdick Machine Tool Co., Cincinnati, O.
Fred. Geier, Cincinnati Milling Machine Co., Cincinnati, O.
W. A. Greaves, Greaves, Klusman & Co., Cincinnati, O.
C. F. Hilker, Hamilton Machine Tool Co., Hamilton, O.
H. C. Hoefinghoff, Bickford Drill & Tool Co., Cincinnati, O.
Fred Holz, Cincinnati Milling Machine Co., Cincinnati, O.
R. K. LeBlond, R. K. LeBlond Machine Tool Co., Cincinnati, O.
William Lodge, Lodge & Shipley Machine Tool Co., Cincinnati, O.
P. G. March, Cincinnati Shaper Co., Cincinnati, O.
C. F. Mayer, Rahn, Mayer & Carpenter Co., Cincinnati, O.
P. E. Montanus, Springfield Machine Tool Co., Springfield, O.
J. G. Oliver, Bardons & Oliver, Cleveland, O.
A. B. Pattison, Aurora Tool Works, Aurora, Ind.
B. B. Quillen, Cincinnati Planer Co., Cincinnati, O.
S. C. Schauer, Cincinnati Machine Tool Co., Cincinnati, O.
G. F. Stewart, Bradford Machine Tool Co., Cincinnati, O.
Murray Shipley, Lodge & Shipley Machine Tool Co., Cincinnati, O.
C. E. Thwing, Draper Machine Tool Co., Worcester, Mass.
A. W. Whitcomb, Whitcomb Mfg. Co., Worcester, Mass.

Several other firms, not members, were represented at the social gatherings, among whom may be noted:

E. R. Fellows, Fellows Gear Shaper Co., and D. L. Ballard, of the Jones & Lamson Machine Co., both of Springfield, Vt.; J. G. Oliver, of Bardons & Oliver; Albert M. May, of the Reliance Machine Tool Co.; A. W. Foote, of Foote, Burt & Co.; Mr. Henn, of the National Acme Mfg. Co., all of Cleveland; R. McCarty, of the Bignall & Keeler Mfg. Co., Edwardsville, Ill.; H. E. Morton, of the Morton Mfg. Co., Muskegon Heights, Mich.; T. G. Meachem, of the New Process Raw Hide Co., Syracuse; C. J. O'Hara, of the Wormer Machinery Co., Detroit, and Mr. Hunt, representative of Manning, Maxwell & Moore.

The following officers were elected for the coming year: President, Joseph Flather; First Vice-President, William Lodge; Second Vice-President, W. P. Davis; Treasurer, Enoch Earle, and Secretary, P. E. Montanus.

Meetings in future will be held semi-annually—the next to be in Worcester, Mass.

* * *

A decided virtue of nickel steel, according to government report, is the facility with which a low carbon steel will harden, it being the practice after a piece is forged and rough-machined, to heat it and dip in oil, which hardens it very much. Afterward the forging is subjected to an annealing process which removes any strains set up in the metal by the sudden cooling which it receives. Nickel steel, after the first cost of production, is not much more expensive to forge than any carbon steel that runs over 40 per cent carbon, and about the same care is necessary in heating and forging as is required by a high carbon steel.

THE STEAM TURBINE.

THE GENERAL PRINCIPLES AND LEADING TYPES OF STEAM TURBINES.

In the September number of MACHINERY editorial reference was made to the recent developments in the steam turbine field, with the promise that an explanation would be given in a later issue of the distinguishing features of the leading steam turbines.

There are now three types of steam turbines manufactured in the United States which have been developed sufficiently to be counted as probable rivals of the reciprocating steam engine. These are the De Laval turbine, made by the De Laval Steam Turbine Co., Trenton, N. J., the Westinghouse-Parsons turbine, made by the Westinghouse Machine Co., Pittsburg, Pa., and the Curtis turbine which is built for stationary purposes by the General Electric Co., Schenectady, N. Y. All of these use steam expansively, and therefore economically, and it will be of interest to outline briefly the principle by which this is accomplished in each wheel. In what follows attention will be paid more to their thermodynamic than to their mechanical or constructive features.

General Principles.

To begin with, it will help matters to make a general statement of what must be accomplished in the successful steam turbine; for, while these points are well understood by students in engineering, it is equally certain that they are not understood at all by the great majority of inventors who have made attempts in the line of steam turbine development. An examination of the patent records shows that while there have been numerous patents granted on steam turbines during the past ten years or so, only a very few of the patent specifications embody the elements of success, and most of them are entirely worthless, and display on the part of inventors an ignorance of what a steam turbine should be and do.

The fundamental principle in any economical steam motor is that the expansive force of the steam must be utilized. The direct-acting steam pump, although serving a very useful purpose, is one of the most wasteful steam users in existence. Steam is admitted to the cylinder at boiler pressure and pushes the piston from one end to the other of the stroke under the same pressure, and the cylinder is in communication with the boiler during the whole time. Steam, however, is capable of much better use than this, because it has a great amount of latent or stored energy which is capable of making the steam in a cylinder expand and push forward the piston after the admission valve has been closed and all communication with the boiler is cut off. This is what is done in the steam engine and in consequence no steam engine, in good working order, requires as much steam or as much coal to operate it as does a direct-acting pump of corresponding power.

Inventors seem to take a great deal of satisfaction in seeing their machinery run. If it is a rotary engine and *it runs* they delude themselves and the public by assuming they have scored a success, without realizing, apparently, that it is quite as important to know *how* it runs from an economic standpoint. If the invention is a steam turbine this is equally true. It is not difficult to make a wheel with blades and to direct a steam jet from the end of a steam pipe against the blades. The wheel will buzz around but it will require so much steam to make it buzz that it will be of no practical use.

In the construction of a successful steam turbine, it is necessary first of all to devise a method for using steam expansively, as in the steam engine; and second, to so proportion the wheel that it will get as much of the available energy out of the steam as possible and convert it into useful work, following in this respect the methods that have been applied in water turbine design. In addition, the fact must be considered that the steam turbine has to rotate at extremely high speeds, thus introducing constructive problems peculiar to itself. As stated at the beginning, it is the steam end of the turbine with which we are chiefly concerned in the present article.

Straight and Diverging Nozzles.

The success of the De Laval steam turbine is largely due to the form of steam nozzle used, by which the jet is directed against the wheel, and it will be shown later that the principles used in proportioning the De Laval nozzle hold with as much force in proportioning the parts of other types of turbines, even where no nozzles are employed.

A great many experiments have been conducted on the flow of steam through straight nozzles or short lengths of pipe, like that in Fig. 1, and it is found that when discharging into the atmosphere at ordinary pressures the velocity of discharge is not far from 1,450 feet per second. When flowing from a boiler pressure of 200 pounds the velocity is about 1,500 feet per second and when flowing from a pressure of 25 pounds, about 1,400 feet, showing that a difference in pressure does not make a great difference in the velocity, owing mainly to the fact that the density of the steam and the weight to be moved increase with the steam pressure.

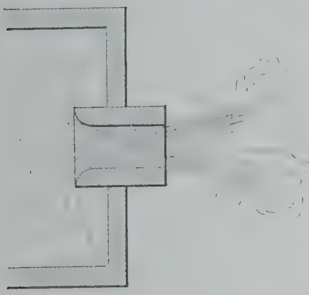


Fig. 1. Straight Nozzle.

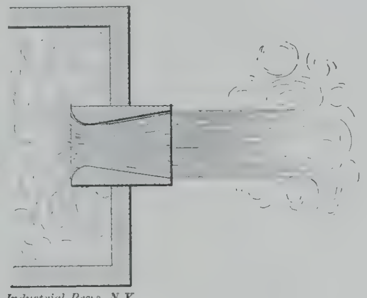
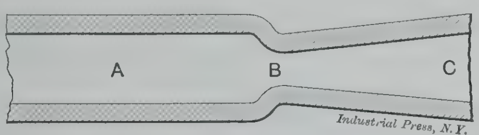

Industrial Press, N.Y.

Fig. 2. Expanding Nozzle.

Another important fact determined by test is that the pressure in the nozzle does not vary greatly from 60 per cent. of the boiler pressure, this percentage being nearly constant under ordinary conditions, without regard to whether the boiler pressure is high or low. When the steam issues from the nozzle, therefore, and drops to atmospheric pressure, it must fall in pounds an amount equal to 40 per cent. of the boiler pressure. In making this drop the steam is free to expand in all directions and its energy becomes dissipated. The jet enlarges after issuing, becomes broken up and scattered and is inefficient for turbine propulsion. The success of the jet turbine must therefore depend upon securing a more efficient jet, one in which the expansion of the steam is made to give it a higher velocity, instead of to increase the size of the jet after it leaves the nozzle.

This is accomplished by using a diverging nozzle, larger at the outlet than at the inlet, similar to the steam nozzle that has been employed for many years in some types of steam injectors. In such a nozzle, as shown in Fig. 2, the steam expands to atmospheric pressure within the nozzle itself and when the steam discharges it takes the form of a solid cylindrical jet, equal in diameter to the outlet diameter of the nozzle. The walls of the nozzle confine the steam so it can expand only in one direction, lengthwise, or the direction in which the steam is flowing. Thus the expansive force of the steam is all utilized in giving the steam velocity, and none of it is wasted in dissipating the jet, as with the straight nozzle. The velocity with a diverging nozzle, when expanding to atmospheric pressure, is about 3,100 feet per second for a boiler pressure of 200 pounds, or more than twice the velocity with a straight nozzle. At 100 pounds pressure the velocity is about 2,800 feet, a gain of nearly 90 per cent. over the 1,450 feet quoted above for the straight nozzle. The gain in *energy*, however, is much greater, since the energies of the two jets are as the squares of the velocities, or in this case approximately as 7,800,000 is to 2,100,000.



Industrial Press, N.Y.

Fig. 3. Expanding Nozzle.

In Fig. 3 is shown a longitudinal section of a diverging nozzle. Steam enters through the pipe, *A*. At *B* is the contracted entrance to the nozzle, and at *C*, the outlet. At *A* the steam is at boiler pressure; at *B* the pressure is 6-10 boiler pressure, as in the case of the straight nozzle, and the velocity at this point is approximately 1,450 feet per second for a boiler pressure of 100 pounds. From *B* to *C* the steam expands from 6-10 boiler pressure to atmospheric pressure. During the expansion part of the steam is condensed and the specific volume—that is, the space occupied by unit weight—is much greater at *C* than at *B*, and still greater than at *A*. In proportioning the nozzle, therefore, the cross sectional area at *C* must be enough greater at *C* than at *B* to allow for the greater specific volume of the steam at the lower pressure; but inasmuch as the steam is moving faster at *C* than at *B*, the areas must be modified accordingly. They may be calculated by compound proportion, making them directly proportional to the specific volumes of the steam at inlet and outlet and inversely as the velocities. Space does not now permit, however, a mathematical discussion of the subject, and readers who care to pursue the subject further are referred to Kneass's Theory and Practice of the Injector, and Peabody's Thermodynamics, both published by John Wiley & Sons, New York.

The De Laval Turbine.

The first turbine to use the expanding nozzle was the De Laval. It consists of a single disk with buckets or vanes on its periphery, against which the steam jets impinge, as indicated in Fig. 4. The steam enters a ring-shaped chamber surrounding the casing of the turbine and cast in one piece with it, and from this it enters the several nozzles that convey the steam to the turbine buckets. The speed regulation is by means of a throttling governor. The power of the turbine depends upon the number of nozzles in action at a time. Each nozzle may be connected with or disconnected from the steam chamber by a hand-operated valve, and the wheel runs with almost as good economy when one nozzle is operating as when there are several, in marked contrast to the action of the reciprocating steam engine under light loads. The expansion of the steam in the nozzles is practically adiabatic, there being no loss in temperature except through radiation, and the expansion in the nozzles is complete. The economy of the wheel, therefore, hinges mainly upon the degree of success in utilizing the energy of the jets. Theoretically the wheel should have a peripheral speed of about 50 per cent. of the speed of the steam jet. Practically this would be impossible without bursting, and the highest speed at which it is thought advisable to run the wheel is 1,350 feet per second, which speed requires a special steel and special construction of the wheel. It is possible, however, to obtain results comparing favorably with steam engine performance even under these conditions. A 300 H. P. turbine was tested recently at the Trenton factory by Dean and Main, consulting engineers, with the following results:

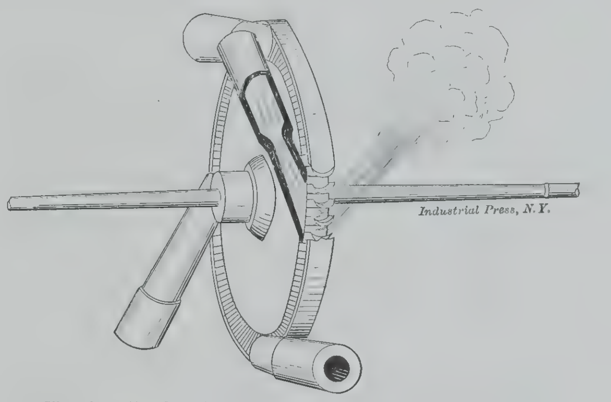

Industrial Press, N.Y.

Fig. 4. Wheel and Nozzles of the De Laval Steam Turbine.

Number of Nozzles Open.	Loads, Brake H.P.	Relative Loads per cent.	Steam per B. H. P. per hour lb.	Quality of Steam.
8	352	100	13.94	Superheated
7	298	85	14.35	"
5	196	56	15.53	"
8	333	100	15.17	Saturated
7	285	86	15.56	"
5	195	59	16.54	"
3	119	36	16.40	"

The very high speed at which the De Laval wheel must run in order to utilize a considerable proportion of the energy in the jet makes it necessary to provide for speed reduction and this is accomplished by spiral gears. While these and other features of construction are of the greatest interest, they cannot be dwelt upon here.

The Westinghouse-Parsons Turbine.

There are three conceivable ways in which steam might be used expansively in a steam turbine. First, by expanding in a diverging nozzle, and allowing the jet to impinge against the wheel buckets; second, by expanding the steam within the spaces between the vanes and between the blades of the wheel as the steam passed through the turbine; and third, by a combination of the two methods.

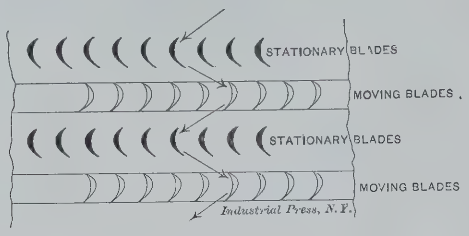


Fig. 5. Blade Arrangement of Parsons Turbine.

The Parsons turbine is in the second group. This turbine has alternating rings of revolving and stationary blades through which the steam passes in much the same way that water passes through the well-known flooded or pressure type of water turbine, as opposed to the impulse type of which the Pelton water wheel and the De Laval steam wheel are examples. The arrangement of the blades and the passage of the steam are indicated roughly in Fig. 5, and the general plan of the turbine in Fig. 6. In the Parsons wheel the whole turbine casing may be said to correspond to the expanding nozzle of the De Laval wheel. Steam enters at one end, at boiler pressure, and expands as it passes among the blades, increasing in speed at the same time, just as in a diverging nozzle. Referring to Fig. 6, steam enters chamber *B* through steam pipe *A* and passes to the right through the first group between the blades to chamber *C*. At this point so much space is required for the steam blades that it is necessary to jump to a larger diameter and the steam flows through a second set to *D*, and finally through a third set to *E*. The disks *a*, *b*, and *c* are for the purpose of equalizing the end thrust of the turbine, due to the pressure upon the blades. Steam is admitted to the turbine in puffs, by means of a reciprocating valve under the control of a governor. The Parsons turbine runs slower than the De Laval turbine, since the steam travels at a much lower rate of speed through all except the last few rings of blades. A Westinghouse-Parsons turbine of somewhat novel design is described in the engineering review of this number.

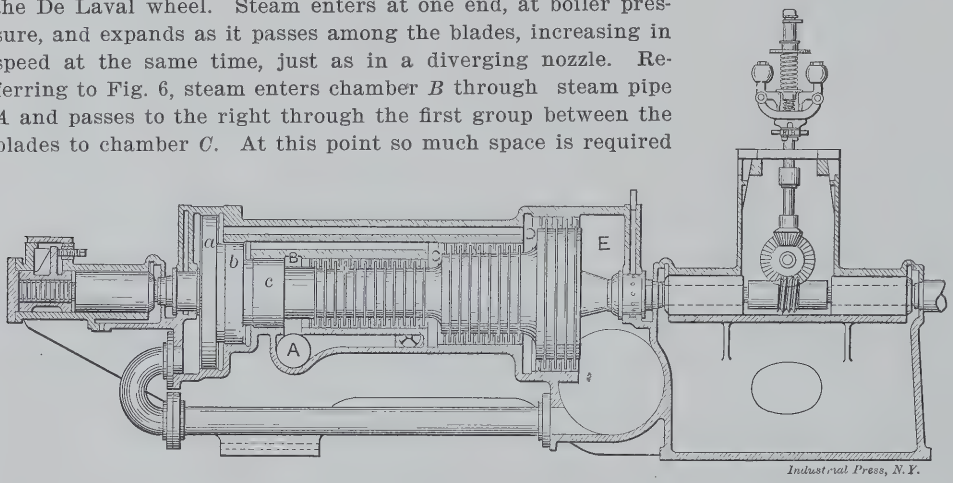


Fig. 6. Section through Parsons Turbine.

The Curtis Turbine.

This, the latest candidate for favor, is a combination of the De Laval and Parsons plans. A steam nozzle is employed to expand the steam, but the expansion is not complete in the nozzle, Mr. Curtis preferring to have a certain amount of expansion occur in passing through the wheel to overcome any retardation that might take place through the friction between the blades and the steam.

As already explained, the best results with a jet turbine are obtained by having the peripheral velocity of the wheel about half the velocity of the steam jet. When, as must always be the case, a turbine wheel runs at a peripheral speed less than one-half the velocity of the steam jet, the steam will have a residual velocity as it leaves the wheel; and the slower the wheel runs the greater will be the residual velocity, and hence the waste energy. In the Curtis turbine a modified form of the De Laval nozzle is used, the wheel is run at comparatively low speed, and the residual velocity of the exhaust steam is used to run a second wheel on the same shaft, thus making a compound turbine.

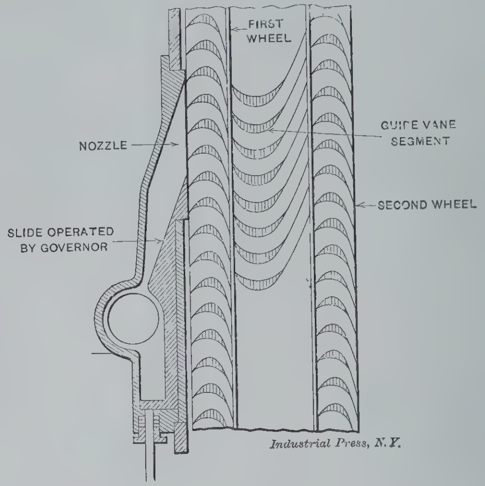


Fig. 7. Section through Nozzle and Vanes of Curtis Wheel, showing Governing Arrangement.

In its simplest form the Curtis turbine consists of two rings of curved buckets mounted upon disks revolving with the shaft. Between the two revolving rings is a group of curved blades in the form of a short segment fixed to the interior of the turbine case. The nozzle is of rectangular cross section, so designed that one side of it can slide under the action of the governor without altering the ratio between the inlet and outlet area of the nozzle, as illustrated in Fig. 7. By this means the quantity of steam delivered is adjusted to suit the load, whereas regulation in the De Laval turbine is accomplished partly by throttling and partly by using one or more nozzles, as required. For marine work the Curtis wheel has two sets of concentric rings of blades. One set is used with a nozzle on one side of the wheel for forward rotation and the other set with a nozzle on the opposite side of the wheel for backward rotation. A number of patents have been taken out by Mr. Curtis embracing features calculated to produce good economy, but the foregoing will give a general idea of the wheel. In the yacht *Revolution*, driven by a Curtis wheel, compounding is carried far enough to reduce the speed of rotation to about 650 revolutions a minute.

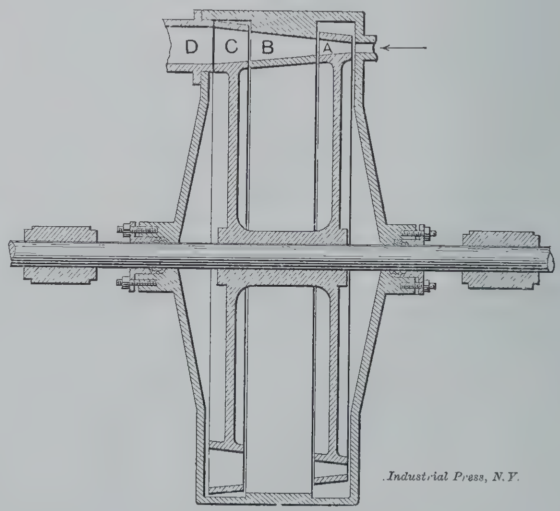


Fig. 8. Section through Curtis Compound Steam Turbine.

Referring to Fig. 8, the method by which compounding is effected and the expansion of the steam occurs is clearly illustrated. Steam enters in the direction of the arrow, passes through the nozzle and the constantly increasing space between the blades. *A* and *C* are the wheel blades, rotating together on the same shaft, *B* represents the intermediate stationary blades and *D* is the exhaust passage.

* * *

A DEVELOPMENT OF MACHINE SHOP FORMULAS.

METHODS FOR FINDING THE COST AND PROPORTIONS OF MACHINES BUILT IN A SERIES OF SIZES.

Stanley H. Moore.

The problem of cost reduction forces itself, with increasing vividness, upon the mind of every person who has to do with the manufacture of machinery. To the "small shop" people, and to those whose product is unsystematized and whose ideas of methods to pursue are, as yet, vague, this article may prove of some assistance.

There are three important means by which the shop product may be systematized: By the use of formulas; by the use of tables; and by the use of charts. As the two latter may be considered as the tabulated, or graphic results of the former we will deal only with the formulas. In determining sizes, weights and costs, these formulas are generally most efficient time-savers. For convenience, formulas in this article will be divided into two classes: The class used to produce the first of a type of machine we will call fundamental; and the class used to produce several sizes of this type of machine, empirical. Upon seeking fundamental formulas in text books and in mechanical engineers' pocket books we are confronted by a diversity of opinions and tabulated results that are, at least to the novice, a bit confusing. These formulas, it is always to be remembered, have their application in the special case under consideration, and are to be used only as guide posts in our journey of design. It is evident to most designers, I think, that some sort of a tentative method must, sooner or later, be resorted to in the type design, for in nearly all machines the governing conditions soon become so numerous or indefinite as to render a subdivision of the problem a necessity.

A certain amount of judgment is absolutely essential in the use of most fundamental formulas, and discrimination is always necessary. To illustrate, suppose that we have to determine the diameter of a particular shaft and we find in our various authorities some such formulas as these:

$$D = C' \sqrt[4]{\frac{H\,P}{N}} \quad \text{(No. 1)} \qquad D = C_1' \sqrt[3]{\frac{H\,P}{N}} \quad \text{(No 2)}$$

The above formulas have their origin in the simpler one of

$$D = C \sqrt[4]{F\,L} \quad \text{(No. 3)} \qquad D = C_1 \sqrt[3]{F\,L} \quad \text{(No. 4)}$$

where $D =$ the shaft diameter, $C =$ the constant for the material, $F =$ the force tending to rotate the shaft, and $L =$ the length in inches from the point of application of F to the center of the shaft. Formula No. 3 is based on the fact that under this condition the torsional deflection of the shaft shall not exceed a predetermined angle per foot in length; and formula No. 4 under the condition that the moment FL produces a torsional stress not more than a predetermined amount per square inch. It is evident that if a complete table of values for C under varying conditions is not given, these formulas are rendered but little better than none.

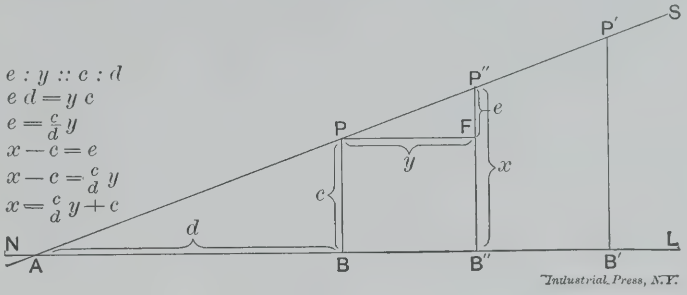
Graphically these two fundamental formulas could be represented by biquadratic, and cubic parabolas respectively; while our empirical formulas would rest on no such basis and would hold true for but a certain series within certain limits. This constitutes the vital difference between our fundamental and our empirical formulas.

Suppose that we have built two or three sizes of a certain type of engine and that they are successful; we desire to put on the market an entire line. Our sizes of this type of engine will run from 10-inch cylinder diameter in the smallest to 30-inch cylinder diameter in the largest. We have built a 12-inch and a 24-inch engine and perhaps an 18-inch. These engines were, as was imperative, tentatively designed. In seeking the derivation of the empirical formula for the length of the crosshead shoe we find that on our 12-inch we have given it an area of 52½ square inches, and on our 24-inch its area is 190⅛ square inches. In each case the length of the shoe was nearly twice its width, so we decide to make it so in our line of engines; solving for the width, we have in the 24-inch.

$$2\,x^2 = 190.125$$
$$x = \sqrt{95.0625}$$
$$x = 9.75$$

making our shoe length for the 24-inch engine 19½ inches, and for the 12-inch engine 10½-inches.

To any scale in Fig. 1, perpendicular to the line *NL*, lay off these shoe lengths *PB* and *P′B′*—10½ inches and 19½ inches, respectively—making the distance *BB′* equal to 12 inches, the difference between our sizes 12 inches and 24 inches. Through points *PP′* draw line *SA* intersecting *NL* at *A*. At *B″*—for our 18-inch size—erect a perpendicular *B″P″*. Draw *PF* intersecting *B″P″* at *F*. Using the notation given in the figure and from its geometry we get the simple equations shown in Fig. 1.



$$e : y :: c : d$$
$$e\,d = y\,c$$
$$e = \frac{c}{d}\,y$$
$$x - c = e$$
$$x - c = \frac{c}{d}\,y$$
$$x = \frac{c}{d}\,y + c$$

Fig. 1.

In this last formula many will recognize an old acquaintance—the equation for a straight line—which in one of Prof. Perry's books proves such an efficient servant. Let us now analyze this equation. From the figure it is seen that $x =$ the desired dimension and that $\frac{c}{d} =$ the rate of increase in the slope of the line. If now we measure the distances and substitute their values for c and d we may determine the ratio $\frac{c}{d}$ which we will call f.

Then $f = \frac{c}{d} = \frac{10\frac{1}{2}}{14} = \frac{3}{4}$: again $x = f\,y + c$, or $x = \frac{3}{4}\,y + 10\frac{1}{2}$.

In interpreting our empirical formula $x = fy + c$, we have

$y =$ a common unit to which all other sizes are to be referred,
$x =$ desired dimension,
$f =$ a factor of y,
$c =$ a constant increment to be added in each case.

The unit value of y as generally selected is a bolt or cylinder diameter, or the capacity of the machine. Obviously in our line of engines we select the cylinder diameter D as our value of y, and our unit formula then becomes $\frac{3}{4}D + c$. The value of c is now determined by direct substitution in the following manner: x being the shoe length, we substitute for it 19½ inches its length on the 24-inch crosshead; then

$$\tfrac{3}{4}\,(24) + c = 19\tfrac{1}{2}$$
$$c = 19\tfrac{1}{2} - 18$$
$$c = 1\tfrac{1}{2}.$$

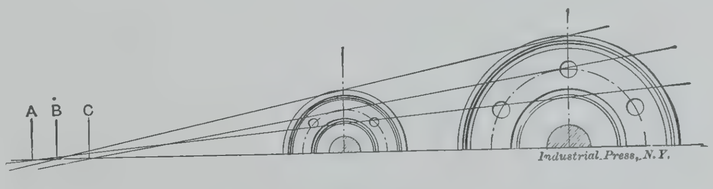


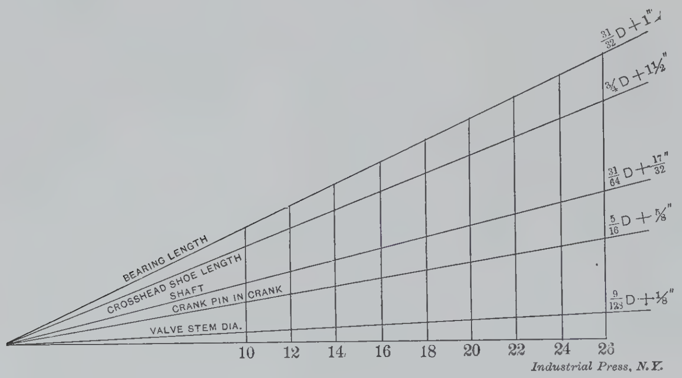
Fig. 2.

Note, that while we have assigned to y and c other values we have not altered the relations; our formula for this particular crosshead dimension now becomes $\frac{3}{4}D + 1\frac{1}{2}$ inches.

For convenience in charting these sizes some point is determined upon as a pole about which these lines (represented by our formulas) are drawn as vectors, the ordinate length for a particular size giving the desired dimension. If now in the determination of other formulas it be found, as is likely to be the case, that these lines do not all pass through a common point it becomes necessary to select one. In well designed machines the intersections of these lines with the base line will come close together and an average of these intersections is selected as a pole. Figs. 2 and 3 will serve to illustrate the purport of this paragraph.

Experienced designers are well aware that the final test of any dimension in a design is that of satisfying all fundamental calculable conditions; nevertheless, the instances where our empirical formulas prove incorrect are very few indeed.

With the design for our line of engines thus systematized, let us consider what are to be the advantages that will naturally result from it. In the first place, the weights of any particular parts, or details of any size in our line of engines may be determined prior to its design or manufacture.



Industrial Press, N.Y.

Fig. 3.

In the determination of weights, cubic contents and similar processes, the use of "differences," as applied to higher mathematics, will not only prove an efficient time-saver, but relieve much of the drudgery attendant upon such operations.

A brief explanation of the use of "differences" is as follows: When we have a series of numbers connected by a regular, though not obvious law, the nature of that law may be discovered by forming a new series of differences between each term of the original series and the next, and then treating the new series (which we may call the series of first differences) in the same way, until we reach a series of differences the law of which is obvious. In the following table will be found both the arithmetic and algebraic solutions of problems by "differences."

In column 1 of the table is given a series of numbers which we suspect follows some definite, though not obvious law, and which we desire to discover. Having proceeded with the several orders of differences, the law becomes apparent early in the process of determining the values in column 3. Referring again to the table, it is evident that the next term of column 3 must be 11, which gives 68 as the next term of column 2 (the series of first differences) and so 312 for the original series. Note that this series can thus be continued indefinitely, and that ultimately, in any regular series, some one series of differences will become a constant.

ARITHMETIC SOLUTION.				ALGEBRAIC SOLUTION.				
COL. 4.	COL. 3.	COL. 2.	COL. 1.	TERM	COL. 5. ORIGINAL SER.	COL. 6. 1ST SER. DIFFERENCES.	COL. 7. 2D SER. DIF.	COL. 8. 3RD DIF.
			7	1	W			
		5				y		
	3		12	2	$W+y$		x	
1		8				$y+x$		c
	4		20	3	$W+2y+x$		$x+c$	
1		12				$y+2x+c$		c
	5		32	4	$W+3y+3x+c$		$x+2c$	
1		17				$y+3x+3c$		c
	6		49	5	$W+4y+6x+4c$		$x+3c$	
1		23				$y+4x+6c$		c
	7		72	6	$W+5y+10x+10c$		$x+4c$	
1		30				$y+5x+10c$		c
	8		102	7	$W+6y+15x+20c$		$x+5c$	
1		38				$y+6x+15c$		c
	9		140	8	$W+7y+21x+35c$		$x+6c$	
1		47				$y+7x+21c$		c
	10		187	9	$W+8y+28x+56c$		$x+7c$	
		57				$y+8x+28c$		
	11		244	10	$W+9y+36x+84c$			
		68						
			312					

Industrial Press, N.Y.

Solutions of Problems by Differences.

It is on the principle of differences that calculating machines are constructed to compute logarithmic tables, etc.

In the algebraic solution of such problems involving the determination of weights and volumes, it will be necessary to calculate these weights or volumes for the 1st, 4th, 7th and 10th terms of our given series. By substituting in the formulas in column 5 the numerical value of W, which is the 1st term in our given series, we may equate these expressions and our calculated values for the 1st, 4th, 7th and 10th terms and determine, by simple algebraic processes, the values of c, x, y, and ultimately, that for which we are seeking the values in the original series, column 5.

The computations concerning the cost of materials logically follow the determination of volumes and weights and are made with comparative ease. However, our next problem concerning the determination of the cost of labor is a more difficult one to solve. Our formula generally expresses this cost as so many cents per pound of product, includes all shop charges, and is established partially by experience and partially by methods suggested in this article.

In many instances it will be found both desirable and convenient to have this cost formula embody the unit dimension. When this is the case, the formula is, as are most cost formulas, established by the tentative methods to which we have just alluded. As the methods employed in the deduction of these formulas render them purely empirical, one or another form of expression may have to be adopted. However, formulas of this class usually assume the form of, or at least may be resolved into, the familiar trinomial of the type form

$$ax^2 - bx + c,$$

where a and b are factors of the unit dimension, and c is a constant.

For the purpose of illustration we will assume that the formula for the cost of labor which we have established is

$$\tfrac{3}{2}D^2 - 15D + 314.$$

In this form the formula gives the total cost of labor in dollars for the size desired. The cost of labor C for our 18-inch engine would then be

$$C = \tfrac{3}{2}(18)^2 - 15(18) + 314$$
$$C = 486 - 270 + 314$$

from which

$$C = 530$$

The computation of a final cost formula, embodying the unit dimension, is the last process in our development of shop formulas; this formula is derived directly from those relative to the costs of material and labor.

When estimating on new work or possibly designs to be submitted, instead of the usual rush in the drafting room with its attendant liability to error, contrast the ease with which our salesman or general manager, substituting in the final formula the current prices of labor and material, accomplishes the desired result. By the use of these formulas surprisingly close estimates may be furnished on sizes not yet designed or manufactured; then, too, we submit to our prospective customer a standard design of known qualities.

I am well aware that the above picture is ideal and somewhat overdrawn, but nevertheless it is an ideal toward which many a shop might strive with much profit to all concerned, and especially to those whose money is invested in the enterprise.

* * *

It would be possible to substitute aluminium for copper in electrical work to a considerable extent—provided the metal can be had in sufficient quantities for the purpose. That is, after all, the most important question. For all immediate purposes the question seems to be answered by the fact that in 1900 the total production of aluminium in the world was 5,570 metric tons, of which the United States furnished 2,053 tons; while that of copper was 492,625 metric tons, of which 272,536 tons were supplied by this country—that is, the total output of aluminium last year was only 1.1 per cent. of that of copper. The price of aluminium at present is about on a par with that of copper, allowance being made for the respective weights. The aluminium quotations, however, have not been regulated by those of copper, but have been based upon the cost of production, and have shown little change during the past year. There is no competition tending to lower them; but, on the other hand, it is to the interest of the producers to keep them as low as possible in order to dispose of their output.—*Engineering and Mining Journal.*

ENGINEERING REVIEW.

A SYNOPSIS OF CURRENT TECHNICAL LITERATURE.

LITHOGRAPHED MARGIN LINES AND TITLES FOR DRAWINGS.

American Engineer and Railroad Journal, October, 1902. p. 317.

Lithographed margin lines and titles for drawings are used in the mechanical engineers' department on the Lehigh Valley. Mr. Gaines has sent a tracing and letter describing the method. When a large number of sheets are lithographed at one time, and the tracing cloth is furnished in rolls, the average cost of cutting the cloth and lithographing the margins and general title is less than two cents per sheet. The average cost of doing the work by hand is about eight cents per sheet, and is not as uniform and regular as when lithographed. In lithographing these tracings, the trimming and margin lines, holes for punching and general titles may be put on as desired, and the tracing sheet is ready for the draftsman, who proceeds with the drawing without delaying to lay out the sheet. He completes the title and fills in the date when the drawing is finished.

PNEUMATIC TUBE SERVICE.

Railroad Gazette, 1902, p. 657.

A pneumatic tube service has been instituted in Boston for delivering parcels from the retail store to the outlying districts. The central station has been erected in the center of the shopping district at the head of Harrison Avenue, and from this station two pairs of tubes have been laid to substations. The tubes are cast-iron water pipes machined at the ends so as to make a close fit. The joints are closed in the same manner as when laying water pipe, using oakum and lead. Curves are laid 12 feet radius to the center line of the pipe. The carriers are metal cylinders provided with five friction wheels at each end to support it in whatever position it may assume in the tube. This is a radical departure from the system commonly used in department stores—in which the carriers are usually provided with felt rings at the ends to act as supports and also as packing to closely fit the tubes. The air pressure required to force the cylinders along the tubes in the Boston system varies from 1.75 to 2.1 pounds per square inch depending on the number of parcels in the tubes at one time. A parcel is delivered by the pneumatic system to the Dorchester station in 10 minutes, a distance that took a team 40 minutes.

THE USE OF ALUMINUM IN METAL PATTERNS.

Aluminum World, September, 1902, p. 231.

Harland Tuttle says that aluminum is a valuable metal for metal patterns, especially small patterns that are carded. On account of its lightness, which is, of course, its chief advantage, much larger patterns can be carded than is possible with the soft metal alloys. For instance, the specific gravity of aluminum is 2.5, while that of the tin-zinc and the tin-antimony alloys is about 7, and of zinc-lead alloy about 9. It will thus be seen that with the same size gates, patterns of aluminum can be carded of three times the volume of the soft alloy patterns with the same liability of breakage. Mr. Tuttle has the care of some three hundred cards, about two-thirds of which are aluminum. There are by actual count between thirty and forty broken joints of the soft metal cards brought in to be soldered to one of the aluminum. The cost of carrying cards to and from the foundry and the repairing of them amounts to quite an item in a year, most of which is saved by the use of aluminum cards.

Another advantage, due to its lightness, is that with fairly large patterns more can be placed on a card, while often patterns which would be too large to card in the heavy alloys can be carded to advantage in aluminum. The necessary amount of rappage to loosen the patterns in the sand is also much less, thereby lengthening the life of the card, while the molders like them much better because of the greater stiffness and ease of handling. The metal is also especially adapted to light, flimsy patterns, as it will not bend out of shape from dropping or by conforming to the shape of a worn-out follow-board, as soft alloy patterns do. In regard to the first cost, aluminum makes a very cheap pattern metal on account of its bulk, aluminum at 30 cents making patterns cost about the same as a tin-antimony alloy at 12 cents. In regard to corrosion of aluminum, patterns have been in continual use for six years, which are in as good condition as the new ones, except more discolored. The patterns grow smoother with use.

COMPRESSING STEEL INGOTS BY WIRE DRAWING IN THE INGOT MOLD.

Engineering News, October 2, 1902. p. 262.

In the production of steel ingots there always exists a tendency toward the formation of a cavity at the center, and gas bubbles entrained in the molten metal at the moment of cooling give rise to blow holes. It has long been a problem for inventors and engineers to procure solidity in the production of these ingots. In the system devised by Sir Joseph Whitworth, the top of the ingot after casting is subjected to heavy pressure. This process has never come into extensive use owing to the fact that in applying pressure at the top, the outer shell of the ingot resists the pressure like a hollow column. What is wanted is to drive the sides of the ingot toward the center, and lateral compression of ingots has been proposed and actually carried out by some American experimenters.

At the recent meeting of the Iron & Steel Institute at Dusseldorf there was described a new method of compressing steel ingots by a so-called wire-drawing process. The ingot mold is made slightly tapering, being largest at the bottom, and is heavily hooped to sustain internal pressure. After the mold is filled with molten metal and solidification has begun the mold is run upon a hydraulic press and a plunger is brought to bear against the bottom of the ingot, forcing it upward, and compressing it by reason of the tapering walls of the ingot mold.

This process has been adopted at the steel works at St. Etienne, France, where a process of ingot compression similar to Whitworth's was in use many years ago.

HEAT TREATMENT OF STEEL RAILS AND STRUCTURAL SHAPES.

American Engineer and Railroad Journal, October, 1902. p. 310.

The temperature at which steel rails and structural shapes are finished bears a vital relation to the character of the product. Rails finished at a high temperature will be coarse in structure, which means rapid wear in service and usually brittleness of structure, although not always the case. Sometimes rails finished at, say, a bright yellow and having a coarse granular structure, will successfully stand the impact of 2,000 pounds falling a distance of 20 or 25 feet. But these coarse-grained rails always give relatively poor wearing service, therefore it behooves the consumer to insist on the finer granular structure as revealed by the microscope.

To prevent rails being produced having a coarse granular structure, it is necessary that they be worked down to the critical point before leaving the rolls to be cut up by the hot saws. In order to have a rail, say, 30 feet long when cold, it is necessary to cut them as much longer as the expansion due to temperature may determine. When the rails are delivered to the saws at high temperatures as was the practice under the old system, it is necessary that these saws be spaced apart about 7½ inches in excess of 30 feet. To insure that the rails be worked down to a lower temperature it has been proposed to limit the excess distance at which the saws may be set to 6¼ or 5¾ inches, but this precaution alone is not sufficient as the rails may be held long enough before the last pass to cool down to the proper temperature and then run through with scarcely any appreciable reduction. The result, of course, is that the structure is coarse since the bulk of the working has been carried on at a too high temperature.

The standard specifications of the P. & R. R. R. require that the temperature of the ingot or bloom be such that with rapid rolling and without artificial cooling after the last pass, the rails may be cut up into 30-foot lengths with the hot saws spaced 30 feet 6 inches. It is desired that thorough working of the steel in the rolls shall not cease until the temperature is as near as practicable to the recalescent point or until about a low red heat has been reached. These specifications also require that a section of rail 4 ft. long taken from the top of the ingot shall stand an impact test of 2,000 pounds falling a distance of 18 feet, the supports being 3 feet apart, center to center. This is for rails weighing 70 pounds per yard. For heavier rails the drop shall fall 23 feet. The anvil block supporting the rail shall weigh not less than 20,000 pounds, and the striking face of the weight shall have a radius of not more than 5 inches. For rails of 70 to 79 pounds per yard, the carbon shall be from .43 to .53; phosphorus shall not exceed .10; silicon not to exceed .20; and manganese .75 to 1.05. The carbon and manganese are allowed to exceed these figures slightly for heavier sections, being .53 to .63 carbon and .80 to 1.20 manganese for 90 to 100 pound rails.

NEW FORM OF PRESSED CAR WHEEL.

Railway and Engineering Review, September 6, 1902, p. 666.

Mr. H. F. Mann, Allegheny, Pa., has recently been granted a patent on a new form of plate-metal car wheel which comprises improvements in the web, tread, and rail-flange, these parts being formed of a single plate of steel or of a single plate of steel and iron, the hub of the wheel being formed separately of suitable material and securely attached to the center of the web. It is claimed that this construction will make a car-wheel which will be light and strong and possessing to a high degree the requisite wearing qualities on the tread and rail-flange. In order to secure the desired results and make a car-wheel which will have the necessary strength and possess the desired degree of hardness on the outer or wearing surface of the tread and rail-flange, the web, tread, and flange are made of a single plate of steel or single plate of steel and iron. If the plate is made of steel, about three-fourths of its thickness is to be composed of low-carbon, tough, and strong steel and about one-fourth of its thickness of high-carbon hard steel. If the plate is to be made of steel and iron, three-fourths of its thickness is to be composed of wrought-iron and one-fourth of its thickness of high-carbon hard steel. In either case the different compositions of metal of which the plate is made are welded together. The hub may be made of wrought steel or iron or of cast metal; but in cases where it is to be secured to the web or washer in whole or in part by welding, it should be made of suitable metal for welding. The accompanying illustrations show a sectional view of a plate, *A*, of steel, or steel and iron of suitable diameter and thickness to form the web, tread, and rail-flange of the wheels; and one form of the web, tread and rail-flange after the plate has been subjected to the operation of suitable dies or other processes to give it the desired form, *B*. In making car-wheels of plates composed of steel or steel and iron, as above described, they should be so formed as to bring the high-carbon hard steel on the outer surfaces of the tread and rail-flange, in order to secure the best and most durable wearing qualities of the plates at these points where it is most needed. The central portion of the web is curved outwardly, so as to furnish a strong bearing in which the hub, *C*, is to be seated and secured. In order to secure additional stiffness to the web, it may be corrugated, and several other modifications are possible.

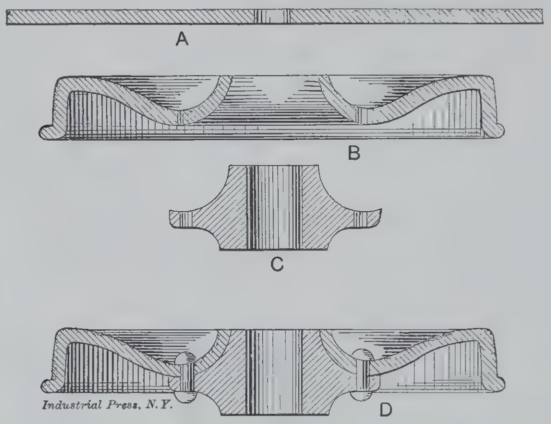


Fig. 1. Pressed Car Wheel.

SAFE SPEED FOR FLYWHEELS.

Monthly bulletin of the Fidelity & Casualty Co.

Wm. H. Boehm.

It is a well understood fact that while an engine pulley or flywheel can be designed to successfully resist the torsional stresses due to any load required of the engine, there is no possible way to overcome the centrifugal force due to speed.

For a given material there is a definite speed at which disruption will occur, regardless of the amount of material used. This is not an uncertain theory, but a mathematical truth easily demonstrated, and is expressed by the following formula:

$$V = 1.6\sqrt{\frac{S}{W}}$$

in which V is the velocity of the rim of the wheel in feet per second at which disruption will occur, W the weight of a cubic inch of the material used, and S the tensile strength per square inch of the material.

In words the formula means that if we divide the tensile strength of the material by its weight per cubic inch, extract the square root of the quotient and then multiply this by 1.6, the result will be the rim speed in feet per second at which disruption will occur.

If instead of the ultimate strength of the material we take its safe strength, the result will be the rim speed in feet per second at which the wheel may be run with safety; the supposition so far being, however, that the rim is made solid in one piece of homogeneous material and free from shrinkage strains.

Applying the formula to determine the safe rim speed for cast-iron wheels made in one piece, we would assume that, if the ultimate strength of small test bars were 20,000 lbs. per sq. in., we could depend upon having 10,000 lbs. in large castings.

Using a factor of safety of 10 on this would give 1,000 lbs. per sq. in. as the safe strength of this material. The weight of a cubic inch of cast iron is approximately 0.26 lb., so that we have for cast-iron wheels:

$$V = 1.6\sqrt{\frac{S}{W}} = 1.6\sqrt{\frac{1000}{.26}} = 99.2$$

per second.

So that 100 feet per second may be regarded as a safe rim speed for cast-iron wheels made in one piece. This corresponds to about 1.15 miles per minute, but as such wheels are likely to contain shrinkage strains, it is not considered good practice to run them faster than a mile a minute.

If the wheel is made in halves, or sections, the efficiency of the rim joint must be taken into consideration. For belt wheels with flanged and bolted rim joints located between the arms, the joints average only one-fifth the strength of the rim, and no such joint can be designed having a strength greater than one-fourth the strength of the rim. If the rim is thick enough to allow the joint to be reinforced by steel links shrunk on, as in heavy balance wheels, one-third the strength of the rim may be secured in the joint, but this construction cannot be applied to belt wheels having thin rims.

Applying the formula to wheels made of cast steel, having an ultimate strength of 60,000 lbs. per sq. in., or a safe strength of 6,000 lbs. per sq. in., and weighing 0.28 lb. per cu. in.; we have.

$$V = 1.6\sqrt{\frac{S}{W}} = 1.6\sqrt{\frac{6000}{.28}} = 234.3$$

per second.

So that a cast-steel wheel made in one piece and free from shrinkage strains could be run with perfect safety at a rim speed of 234 feet per second, corresponding to 2.66 miles per minute.

It will perhaps surprise some of our readers to learn that wheels made of wood may be run at a higher speed than those made of cast iron. Wood, however, is one of the very best materials that can be used for flywheel construction, and many large wheels have been constructed of this material and are giving satisfactory results.

Applying the formula to hard maple having a tensile strength of 10,500 lbs. per sq. in., and weighing .0283 lb. per cu. in., we have, using a factor of safety of 20, and remembering that the strength is reduced one-half because the rim is built up of segments,

$$V = 1.6\sqrt{\frac{S}{W}} = 1.6\sqrt{\frac{262.5}{.0283}} = 154.1$$

per second.

So that a well-made maple wheel may be run with perfect safety at a rim speed of 154 feet per second, which corresponds to 1.75 miles per minute. Or comparing two wheels of the same diameter, one of cast iron, the other of maple, the number of revolutions per minute for the maple wheel may be 54 per cent. greater than for the cast-iron wheel. One hundred and fifty-four feet per second would not, however, be a safe rim speed for the wood wheel if made in halves or sections, on account of the weakness of rim joints.

Of late years wheels for large electric plants have been built up of steel plates riveted together, and wheels for special work or unusually high speed have been specially designed. It is questionable, however, whether the complicated built-up steel construction is profitable for wheels of standard steam engines as commercially built. When an engine runs fast enough to burst a well-made cast-iron wheel it is doubtful whether anything could save it. The small amount of time required for the additional acceleration necessary to burst a steel wheel at that stage would be little, and when the crash did come, it would be all the more disastrous.

From the above formulas it will be seen that the stress in the rim of a wheel increases with the square of the speed, or, to put it another way, the factor of safety on speed is always the square root of the factor of safety on strength.

If the speed be tripled, for example, the stress in the rim becomes nine times as great as before; that is, with a factor of safety of nine on strength, there is a factor of safety of only three on speed. It will be understood from this that the stress increases enormously for even a slight increase in speed.

Let us consider the usual cast-iron, sectional, belt wheel having flanged and bolted rim joints located between the arms. As pointed out above, such joints average a strength of only one-fifth the strength of the rim, and no joint of this kind can be designed that will have a strength greater than one-fourth the strength of the rim.

If this wheel had at normal speed a factor of safety of 12 in the rim, then with joints of maximum strength the factor of safety in the joint would be only 3 on strength or 1.73 on speed. That is, an increase in speed of 73 per cent. would burst the wheel.

The wide gulf in this case between the apparent factor of safety of 12 on strength and the real factor of safety of 1.73 on speed is appalling. This is, however, only another warning that things are not always as they seem.

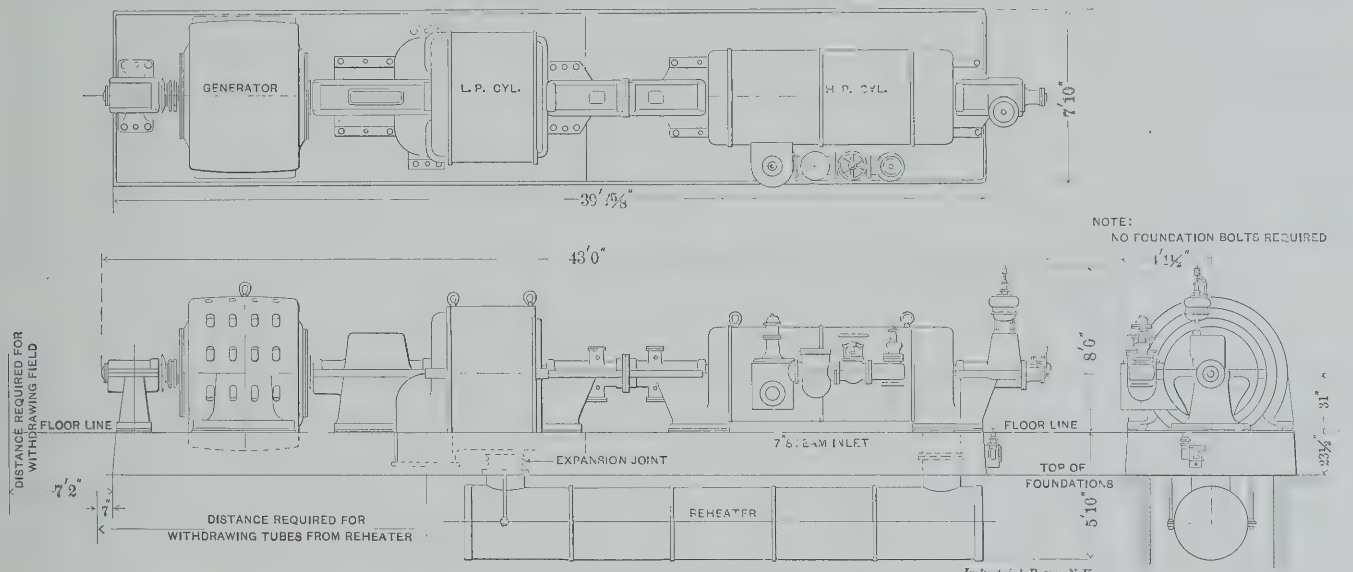
As a matter of fact, few wheels have a margin of safety of 73 per cent. on speed. In the accident at the Amoskeag Mills, in which a 30-ft. wheel wrecked the building, killed two girls and badly injured the assistant engineer, the evidence proved that an increase in speed of only 20 per cent. caused the disaster. Many wheels in use to-day are running on a narrower margin than this.

It will now be understood why racing is so frequent a cause of flywheel accidents. Some slight accident to the governor or valve gear of the engine occurs, and away goes the wheel, causing a costly if not fatal wreck. The stress in the rim increases so rapidly with increase of speed that sound wheels amply safe at normal speed, go to pieces without warning, and apparently without cause.

STEAM TURBINES FOR THE RAPID TRANSIT SUBWAY, NEW YORK.

Power, October, 1902, p. 40.

Steam turbines of the Westinghouse-Parsons type are to be used by the Rapid Transit Construction Co., New York, in connection with the lighting of the subway now under process of construction. There will be three independent direct-connected units, aggregating 3,750 kilowatts capacity, and both turbines and generators will have unique features.



Industrial Press, N.Y.

Fig. 2. Westinghouse-Parsons Steam Turbines for New York Subway.

The most striking constructive feature in the turbine is the separation of the high-pressure and low-pressure sections and the introduction of a reheater between them. This arrangement provides for a center bearing for the turbine shaft, thus reducing the distance between bearings and allowing the use of a much lighter shaft.

The turbine proper is of the multiple expansion parallel-flow type arranged, as above noted, in tandem compound. Steam entering at the throttle valve is passed through a strainer for removing all foreign matter, and thence through the poppet inlet valve, the period of admission being controlled as in former types by a sensitive fly-ball governor. The steam, after admission, expands through successive rows of alternate moving and stationary blades, forming the expansion stages of high-pressure as well as low-pressure cylinders. At a considerably reduced pressure and correspondingly augmented velocity, the working fluid now enters the reheater where it comes in contact with the superheating surface, with the result that entrained moisture is entirely re-evaporated and the low-pressure cylinder is furnished with dry steam. A similar expansion takes place in the low-pressure cylinder with a subsequent reduction of pressure and increase of velocity, and the exhaust steam, entirely deprived of its available energy, escapes through the exhaust port situated underneath the rear bearing of the low-pressure cylinder. As in former types, a by-pass is provided, connecting high-pressure and low-pressure cylinders, by means of which the turbines will be enabled to carry continuously an overload of 50 per cent. with condenser, or full load without the aid of condensing apparatus.

Connection will be provided between the generator shaft and the two parts of the turbine shaft by a special mechanical coupling. The governor will be of the fly-ball type located at the extreme end of the turbine and driven by worm gearing from the turbine shaft. It will be provided with a safety stop which, in combination with an auxiliary valve, will automatically cut off the steam supply should the speed of the turbine exceed a predetermined limit. This stop is adjustable and by its use any speed limit may be imposed upon the operation of the turbine equipment.

The construction of the reheater is entirely similar to that employed by the builders in their many types of vertical and horizontal Corliss engines. It consists of a riveted boiler plate shell, 23 feet in length and 3 feet in diameter, provided with numerous longitudinal charcoal iron tubes expanded into flanged steel tube sheets which are riveted to the shell at a short distance from the ends, thus providing a chamber at each end of the reheater for receiving and discharging the steam on the way from the high-pressure cylinder. This reheater is supplied with live steam from the boilers. To facilitate starting the turbine a small by-pass around the throttle valve will permit the introduction of a small amount of live steam for warming up the cylinder walls and rotating parts.

With 175 pounds boiler pressure the steam consumption is guaranteed not to exceed 15.6 pounds per horse power hour at full load, 18.5 pounds at half load, and 23.3 pounds at 25 per cent. load. With 75 degrees superheat the consumption is guaranteed to be about 2 pounds less than at the different loads.

The three turbo-generator sets will be installed in the Rapid Transit power house at North River and Fifty-ninth Street, Manhattan, occupying the center of the present engine room. They will rest on steel and concrete foundations built up from a solid-rock bed, and will be in line with the main generating units. The floor space occupied will be 1,824 square feet total, inclusive of 3¾-foot passageways, or 945 square feet net, which furnishes a comparative figure of 0.2 square foot per electrical horse power against 0.86 square foot per indicated horse power for three horizontal cross-compound Corliss engines of equal capacity, including generators.

HORSE POWER OF BOILERS.

Power, October, 1902, p. 13.

C. G. Robbins says: In a recent catalogue of a well-known maker of engineering specialties the writer noticed the following approximate rules for calculating the horse power of various kinds of boilers. The rules are intended for use in determining the proper sizes of injectors and other apparatus when the exact dimensions or heating surface of the boiler is unknown or hard to obtain:

Kind.	Horse Power.
Horizontal tubular	$= \text{Dia.}^2 \times \text{Length} \div 5$
Vertical tubular	$= \text{Dia.}^2 \times \text{Height} \div 4$
Flue boilers	$= \text{Dia.} \times \text{Length} \div 3$
Locomotive type	$= \text{Dia. of Waist}^2 \times$ length over all $\div$ 6.

All dimensions to be in feet.

In the first and third cases the length is the length of the tubes or that of a "flush-head" boiler and does not include the extended smokebox. In the second case, the height is that of a plain vertical boiler in which the upper part of the tubes is above the water line; it is not the height of a boiler with submerged tubes.

The extreme simplicity of the rules aroused curiosity as to their accuracy, and comparisons were made between manufacturers' ratings and ratings calculated by the formulas above. The results are given below. They agree very closely, except in a few of the larger sizes of tubular boilers, where the calculated rating falls below that of the manufacturer. And in these sizes it will be noticed that the heating surface per horse power is less than in the smaller sizes where the two ratings practically agree.

It is quite possible that the ratings of other manufacturers would show a better or worse agreement. In any event, the rules prove to be valuable for just what is intended, and will save considerable trouble in measuring up and calculating the power of existing boilers when ordering injectors, feed pumps and the like.

HORIZONTAL TUBULAR.

Diameter (inches) x Length (feet)	36 x 8	42 x 10	48 x 12	54 x 15	60 x 15	66 x 15	72 x 16	78 x 18	84 x 18
Heating Surface	232	370	568	800	1010	1249	1674	2115	2511
Manufacturer's Rating....................	15	25	40	60	75	90	125	175	200
Rating by Rule	14.4	24.5	38.4	60.8	75	90 8	115.2	152.1	176.4

LOCOMOTIVE TYPE.

Waist Diam. (inches) x Length (feet).....	40 x 14	42 x 14⅓	44 x 16⅓	48 x 17½	54 x 18½	56 x 19½	58 x 19¾	60 x 21	62 x 22¼
Heating Surface..........................	268	309	400	503	596	710	809	898	1050
Manufacturer's Rating....................	25	30	40	50	60	70	80	90	100
Rating by Rule	25.9	29.3	36.6	46.7	62.5	72	77	87.5	90

VERTICAL TUBULAR.

Diameter (inches) x Height (feet)	24 x 5	30 x 5	30 x 6	36 x 7	40 x 7½	44 x 8	48 x 8	48 x 9	54 x 9
Heating Surface..........................	58	84	100	180	238	292	358	480	578
Manufacturer's Rating	5	7	8	15	20	25	30	40	50
Rating by Rule...........................	5	7.8	9.4	15.6	20.6	26 8	32	36	45.6

TWO-FLUE BOILERS.

Diameter (inches) x Length (ft.)	36 x 18	36 x 22	42 x 20	42 x 24	44 x 26	48 x 26	40 x 30	50 x 32	54 x 34	60 x 33
Heating Surface	206	253	285	338	393	415	478	542	610	663
Manufacturer's Rating	15	26	25	30	35	40	45	50	60	70
Rating by Rule..................	18	22	23.3	28.7	31.8	34.7	40	44.5	51	55

Table of Horse Power of Boilers.

PROPER HANDLING OF COMPOUND LOCOMOTIVES.

Paper read before the Tenth Annual Convention of the Traveling Engineers, Chicago, Ill., September 12, 1902, by W. J. Carroll.

The economy in fuel with the compound locomotive is the result of passing the steam through two or more cylinders, with the object of obtaining, by a succession of expansions, more work from a given quantity of steam than can be obtained from the use of steam through one cylinder, because the range of temperature in each cylinder is less, from the fact that compound engines use less steam than single-expansion engines, and that less water is used and less fuel is required to evaporate the water.

It is not expected that a compound locomotive should haul a heavier train or at higher speed than a single expansion locomotive of the same weight and class. No locomotive will haul more than its adhesion will allow. The compound will, however, keep a train moving at slow speed on heavy grades, where a single expansion locomotive will stall—this being accounted for from the fact that the pressure on the crank-pin is more uniform throughout the stroke.

On all styles of compound locomotives the exhaust is much milder than on single-expansion engines. This is due to the fact that the exhaust pressure is much less, and on this account much better results can be obtained by maintaining a light fire. With a deep, heavy fire the mild exhaust does not create sufficient draft to work the fire.

The fireman need not feel alarmed at any amount of abuse or carelessness on part of the engineer, by using the reverse lever in full stroke, or in slipping the engine, because he cannot tear the fire to pieces, as on a single expansion. It is also noticeable that when a compound locomotive is properly adjusted and fired, the great annoyance of cinders, black smoke, sparks, etc., is overcome to a very great extent. In drifting down grades the ash-pan dampers should be kept closed.

From the experience an engineer has in handling a single-expansion engine, he should not require any further introduction to the reverse lever, but he should use it for what it is intended. The reverse quadrant on all compound locomotives should be so arranged that it cuts off steam in the high-pressure cylinder at about one-half stroke; shorter cut-off will result in excessive compression in the high-pressure cylinder.

Dry steam is to be considered even more necessary with the compound than with the simple engine. To reach this end a desirable depth of water over the crown sheet has been found in practice to be about 11 inches, and it will be found well to keep the water in the water glass at such height as to produce this depth over the crown sheets. Some little difficulty has been encountered with the by-pass valve, due to gum being formed by smoke drawn in. To obviate this, it has been found well to put a ½-inch hole in each end of the valve as near the head as possible, and apply a little valve oil. The blowing of the piston rod packing should receive careful attention, as it not only wastes steam, but the condensation in the winter obstructs the view of the engineer. With more experience on the part of mechanics with compound locomotives, and the higher education of them in this line, the compound will be found, in the opinion of many, to give much better results. The compound locomotive being of a somewhat more intricate design suffers at the hand of the mechanic in the roundhouse more than the simple engine. The steam leakages have not been overcome, and other faults in design have operated to cause the engine men to condemn this form of engine without fair trial.

HISTORY OF THE UNDER-FEED STOKER.

Proceedings of the New England Cotton Manufacturers' Association, September-October, 1902.

In a paper upon under-feed stokers, Mr. Geo. C. Tewksbury gives the following sketch of the history of the Jones stoker:

To Evan William Jones, of Portland, Oregon, is due the credit of first inventing an under-feed mechanical stoker that has been successful to a degree almost unknown to mechanical stokers—not only of the under-feed type, but of stokers in general.

The circumstances leading up to the invention are somewhat peculiar and, I am quite sure, will be interesting in view of the final results obtained. In the State of Oregon, where Mr. Jones resided, wood was more easily obtained than any other fuel; hence, Oregon fir was most universally used for power and domestic purposes. The residents of Oregon—certain portions of which may be classed as semi-tropical—have all the characteristics of residents of semi-tropical countries, particularly in the respect that they are inclined to take life easy and do as little work as possible. The result has always been and probably always will be, so far as the furnishing of wood for fuel is concerned, that up to the time of its delivery no attempt is made to dry the same and consequently it is in a very green state when used. Now, taking into consideration the fact that Oregon fir has a high percentage of moisture and retains same much longer than most other woods, we can readily appreciate the necessity for some means of quickly and effectively drying the wood before using.

Mr. Jones was at the time mentioned, about 1888, president of the Union Iron Works of Portland, Oregon, and was known throughout that section as having more than ordinary mechanical skill. Certain customers of his (interested in the manufacture of paper) found it impossible to keep up steam with the green wood that they were compelled to use. One of these customers took the matter up with Mr. Jones and asked him to devise some scheme by which the wood could to a reasonable extent be dried before it was necessary to use same for fuel.

After giving the matter considerable thought Mr. Jones arrived at the conclusion that the only practicable way was to dry the fuel with the same heat that must be obtained to steam the boilers. After arriving at this conclusion he made up his mind that the only possible way to accomplish the desired end would be to introduce the fuel from beneath the fire line, carrying a fire on top of the fuel instead of on the grates that were until that time used.

After making an attempt to introduce the fuel from underneath by means of levers, he found that such a course would not be practicable and he therefore provided a steam ram for the purpose. The wood used was of the ordinary length (four feet) and was forced from below by means of the ram. After the furnace was once filled with wood (which before steam was obtained in the boilers could be placed in the furnace by hand) a fire was started on top of the wood. The supports for the wood consisted partially of solid iron plates, and at the rear of the furnace, which was inclined upward, grates were used.

The result obtained was more than had been expected. An intense fire was created in the furnace, naturally at the top of the bed of fuel. This intense heat served to dry the fuel that was beneath same. In the drying process a considerable quantity of gas was thrown off, and the same naturally passing upward was consumed. Therefore the fuel—before being passed into the zone of combustion—was quite thoroughly dried and was in a proper state to give forth all the heat units contained therein.

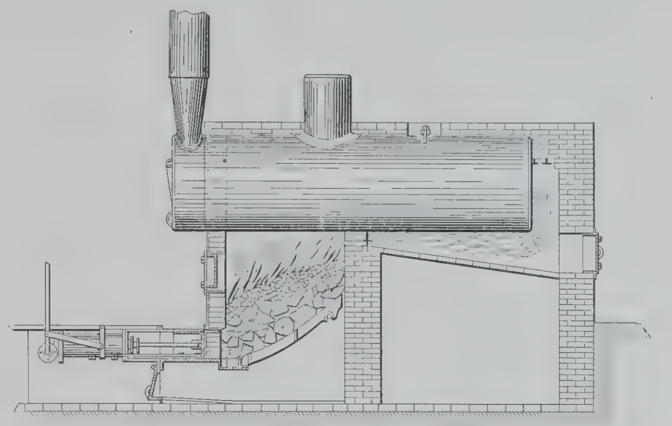

Industrial Press, N.Y

Fig. 3. Original Under-feed Stoker.

The accompanying illustration will give a fair idea of Mr. Jones' invention, which proved to be entirely practicable, and which was used successfully in a number of plants in Portland and vicinity for a number of years. Some of these are probably now in use, although since they were designed coal has been found in the vicinity of Portland that can be used for fuel—and at certain times is cheaper than wood.

Realizing that the field for a mechanical stoker designed solely for the use of wood for fuel was very limited and that equally if not more satisfactory results could be obtained by the use of bituminous coal for fuel under the same system, because of the high proportion of volatile matter contained in same, Mr. Jones naturally turned his attention to the devising of a mechanical stoker for that purpose.

The fundamental principle of under-feeding which had already occurred to Mr. Jones very forcibly now became a fixed idea in his mind. You are undoubtedly more or less acquainted with this principle, that is, the introduction of the air above the fresh or green coal, but below the incandescent bed of fuel, at or about the point where the volatile gases are liberated; which gives a thorough mixture of the gas and air before reaching the zone of combustion and which results in the practically complete combustion and the utilization of the heat of these gases which in ordinary hand-firing is to a great extent lost.

After having made the necessary drawings and after reaching the conclusion that a stoker would operate successfully, he obtained permission from the authorities of the Portland Cable Railway in Portland, Oregon, to equip two of their furnaces with same. Since then various changes and improvements have been made.

While I have stated that it is not my intention to enter into a technical description of the under-feed system of mechanical stokering, a brief statement of the theory will not be out of place.

Properly operated the system represents a gas producer and gas consumer in one furnace. The green fuel being introduced from the under side of the furnace proper, the incandescent fuel resting thereon must necessarily liberate the volatile matter in the green fuel. Air being introduced at the point where gases are being liberated—this point being underneath the mass of incandescent fuel—a thorough mixture of the air and gases at a high temperature is certain to be obtained. This combustible mixture must pass upward through the body of incandescent fuel and must be consumed. The result is the utilization of practically all of the heat-producing elements in the fuel, making more nearly perfect combustion than can be obtained in any other way; and thereby insuring freedom from smoke.

From the writer's experience he believes that an hourly fuel consumption of about 1,000 pounds of coal is as great as should be attempted with one under-feed stoker. Attempts have been made by manufacturers of under-feed stokers to increase the fuel consumption above named, but in the main they have not been, and in the writer's opinion, cannot be successful with all classes of coal. When greater fuel consumption is desired in any one furnace, two or more stokers should be used.

SPEED TESTS OF STEAM AND ELECTRIC TRAINS.

Scientific American, October 4, 1902, p. 216.

The most direct evidence thus far afforded that the New York Central Railroad is taking active steps toward the installation of electric traction for its suburban service in New York City is a series of tests which have recently been carried out on the experimental track of the General Electric Company at Schenectady. These tests were made with a view to determining the relative efficiency of steam and electric traction in such suburban passenger service as is carried on by the New York Central Company. The primary object of the test was to make a comparison of the rate of acceleration of the same train when hauled by a New York Central suburban engine and by a pair of electric motor cars, such as would be used were the suburban lines to be equipped with third-rail electric traction. For the purpose of the test, a train of six cars was made up, which included five standard passenger coaches of the New York Central Railroad preceded by a dynamometer car. The engine selected was one of the big tank engines especially designed for the suburban service of the New York Central Railroad, the engine being provided for this purpose with large heating surface and cylinder capacity and small-diameter six-coupled drivers. These engines have a total weight of 214,000 pounds, of which 128,000 pounds is on the drivers; a total heating surface of 24,065 square feet; cylinders 20 x 24 inches; a boiler pressure of 200 pounds to the square inch and a tractive power of 25,900 pounds. They have proved very successful, the acceleration being unusually rapid. Indeed, for this class of work, where stops are frequent, they are probably the best engines of their kind in this country to-day, and hence admirably adapted for a comparative test of capacity of acceleration with electric motor cars. For the electric test two General Electric motor cars, one weighing 73,000 pounds and the other 70,000 pounds, were used. These cars are 54 feet in length, and are equipped with four "G E 55" motors, all axles being provided with motors and the two cars together giving about the same weight on drivers as the steam locomotive. The test was, therefore, perfectly fair, the acceleration being directly comparable for trains of equal weight. The drawbar pull, speed and time were recorded by the same dynamometer car in all cases, the engine simply being unhitched and the two motor cars coupled up for the alternate trials. In carrying out the tests, the train of six cars with its engine or its electric motors, as the case might be, was started from rest and run over one mile of track, the acceleration being made as rapidly as possible with the power available. These runs were repeated, dropping off one car at a time, and a careful record was kept of the speed attained in 10 seconds, 20 seconds, 30 seconds, etc. The New York Central coaches weighed each from 48,200 pounds to 60,250 pounds, and the total weight of the train behind the engine or electric cars varied from 157 tons down to 23 tons.

The electric runs were made upon the General Electric Company's experimental track against a head wind of 15 miles an hour. In the middle of the run there was a 6½ degree curve, the frictional effect of which was assumed as equivalent to the 1-10 per cent. upgrade of the steam runs, which were made on the New York Central main line adjoining the electric works. In the case of the steam runs there was also a head wind of 15 miles per hour. Although the locomotive was especially built for rapid acceleration, having a large firebox and heating surface, the pressure dropped from 200 pounds at the commencement of the mile to less than 185 pounds during the early part of the acceleration. In starting, the throttle was opened wide and steam was used for the full stroke, the engine being hooked up as acceleration proceeded. In neither case was there any slipping of the driving wheels. Although the steam locomotive was able to exert a tractive effort at starting equal to that obtained by the electric motor cars, this high tractive effort was not maintained, but fell immediately with the increase of speed, in spite of the most expert handling of the throttle and reversing lever.

A comparison of the results proves that the electric motors can better utilize the weight upon their drivers during acceleration than a steam locomotive, the motor covering the same distance in the same time with less energy expended and at less maximum speed than a steam locomotive, owing to its being able to maintain its maximum accelerating rate for a longer period. In making the tests the power was kept on until the three-quarter-mile post was reached, when it was shut off and the brakes were applied so as to bring the train to rest as near the mile post as practicable. The steam train ran from 5 to 15 per cent. over a mile before the train was brought to rest, and the electric train from 2 to 4 per cent.; but, in spite of the longer distance covered, the average speed of the steam runs only approached that attained in the electrical runs over a shorter distance. Since the electrical runs all show a lower maximum speed and a higher average speed than those made with the steam locomotive, the energy consumption of the electric runs should, therefore, be less for the same work done than with the steam locomotive. Since the motors of electric trains may be placed upon the trucks of ordinary passenger coaches, there is a saving of weight due to the elimination of the locomotive and tender, and the authors of the paper point out that, hence, the true basis of comparison between steam and electrically-propelled trains should be the energy per seat mile rather than per ton mile. As an illustration of the advantages, in point of economy of power, of electrical traction over steam, it was found that for a train of six cars the watt hours per passenger required in a steam train are 43.9, as against 29.7 in an electric train. In a three-car train the watt hours for steam would be 77.4, as against 37.5 for electricity. In a comparison of coal consumption, based upon the actual service of a steam locomotive for twenty-four hours covering four trips between North White Plains and the Grand Central Station on the New York Central road, it was found that the coal consumed per effective horse power hour was 15.6 pounds. In comparing this with electrical traction, it is assumed that the ratio of effective horse power output of motors to the indicated horse power of the central station engine is about 50 per cent. The average coal consumption per horse power hour at the electric power stations is assumed at 2½ pounds, and at this figure the coal per effective horse power output at the electric motors would be 5 pounds. Assuming the head air resistance as 10 per cent. and the increased weight of the cars due to their electrical equipment as 20 per cent., the actual comparison of coal consumption works out in the ratio of 6.6 pounds per horse power hour for electric traction and 15.6 pounds for steam traction. Assuming the cost of coal for electrical power is about a third the total cost of that power if maintenance and interest on investment be included, it is concluded that the actual gross cost of electrical power would closely approximate the coal consumption cost of the steam locomotive in this class of service, the maintenance and attendance cost of the electrical equipment being, however, considerably in favor of electrical power.

THE AMERICAN ENGINEER IN ENGLAND.

Journal Western Society of Engineers, Aug., 1902.

About a year ago the British Westinghouse Electric & Mfg. Co. decided to build a plant in England for the manufacture of their product. The plant was to be constructed on the same plans as those used for the Westinghouse plant at East Pittsburg, Pa., with the addition of a steel foundry and of an iron foundry.

The plant was designed by Mr. Thos. Rodd, of Pittsburg, and the work of construction was intrusted to a Manchester architect, but under his supervision the work progressed so slowly that it was evident to those interested that something must be done to hasten the work. It was generally conceded by English builders that it would take five years to erect the works contemplated, but a delay of a year or two years meant an almost inestimable loss, and therefore, a year ago last March, Mr. J. C. Stewart, of the contracting firm of James Stewart & Co., St. Louis and Pittsburg, having gathered around him a party of six American engineers and foremen, sailed for England, and on arriving there took immediate charge of the work. Mr. Wm. G. Sloan, who was one of the party, gives an interesting account of their experiences, in the *Journal of the Western Society of Engineers*, from which we quote:

"The question was, 'How can the plant be completed in the shortest possible time?' The Americans interested in the business naturally looked to America for an answer to this question, and the contracting firm of James Stewart & Company of St. Louis and Pittsburg, agreed to take hold of the work and push it through, saying they could complete the work in fifteen months.

"We found the work in charge (under an architect) of a clerk of works, who had a small office in one part of the grounds. This man had perhaps a dozen assistants, each having his little office in some part of the grounds, each seemingly as far as possible from the others. The first thing done was to build an office large enough to accommodate all the necessary force, so as to bring them under the immediate supervision and influence of the American management.

"All these men had been in the habit of coming to work at nine o'clock in the morning, and leaving about five in the afternoon; they were requested to be on hand when the work started and to remain until quitting time, and this request caused about half of them to seek employment elsewhere, one of them saying in his letter of resignation, 'A man cannot be a gentleman and work under the American administration.' It may be of interest to state in this connection that the average rate of pay of these clerks and inspectors did not exceed fifty dollars per month.

"One custom we had the most difficulty in breaking down, was the old established one of stopping for the breakfast hour. The men started work at seven o'clock in the morning and at half past eight the work stopped for half an hour for the men to eat their breakfast. This consisted of bread and tea, and each man brought his tea and teapot with him to the work, and as I say, right in the best part of the morning, they all stopped work, and gathering in groups of three or four in a place, built little fires on the ground, heated the water and made their tea. You can readily understand, when you consider that at times we had as many as 3,000 men at work, how serious an objection this break in morning work would be; the men losing not only the half hour between 8:30 and 9 but also wasting considerable time in stopping work and getting started again. We helped matters to a great extent by building a furnace and having the water hot for the men; making it a rule that no other fires should be lighted on the grounds. At the same time we discouraged in every way possible the keeping up of the custom, and finally, one by one, the different trades acquiesced to our wishes in the matter, and before the work was done, all but the bricklayers had given up the custom.

"If one department of our work created more comment and discussion than another, it was the work of our bricklayers. Shortly after we had taken hold of the work, the fact that we were laying 900 brick per man per day was published, and from builders in all parts of the country came the cry 'Impossible, the work of our bricklayers does not average over 400 or 500 brick per man per day,' and yet later on as the organization became better, and the men became accustomed to our methods, this average of 900 brick per man per day was doubled on the same class of work. So much comment was made on this, that on the construction of a large brick stack, we went so far as to have the foremen make affidavit each night as to the number of brick laid and men employed on this particular piece of work. The men averaged over 1,900 brick per man per day for a month, and the best day's work was 2,100 brick per man per day.

"In this connection I may say that the brick used in this district are larger than those we have here, being 3 x 4½ x 9 inches. This record was made possible by providing the most approved hoists for material, so as to have no delay on the part of men waiting for brick or mortar, and by the fact that we used a thinner mortar than was commonly used in England, thus saving time and labor in spreading the beds and setting the bricks in place; also that we were able to get and hold the best men by paying more than the union rate of wages, which for bricklayers is only 20 cents per hour.

"I will venture to say, that if you would go to 90 per cent. of the contracting engineers or builders in England, and ask, How many brick are you laying per man per day, or just what is your concrete or masonry costing you per yard in place? the answer would be 'I do not know.'"

Mr. Stewart did better than he said he would. He said it would probably take him fifteen months and the work was practically finished in a year.

The cost of the buildings, with the machinery installed, was about $8,000,000; without the machinery, about $4,000,000 or $5,000,000."

THE RELATION OF THE DRAFTSMAN TO THE WORKSHOP.

Engineering Magazine, October 1902, p. 98.

Mr. W. H. Booth, in writing upon this subject presents it to the reader from the view point of the British draftsman. To begin with, the term "draftsman" is vague; for the name of engineer, which includes it, includes also, in British parlance, a vast concourse of men, ranging from the designer of a Forth Bridge to the manufacture of iron bedsteads or the driver of an engine. His position is by no means a pleasant one, as he very seldom comes in contact with the outside world, and receives but slight recognition from his superiors. It is often said that he gets all the blame when things go wrong and secures none of the credit for what scores a magnificent success. The insistence upon petty details is often a drawback to the draftsman's position.

The chief draftsman of a certain colonial railroad known to me once insisted that the draftsmen under his charge, who were frequently called upon to make sketches in the running shed, should actually make these sketches to scale, and he insisted they should figure these sketches with a particular pattern of figure, fractions being shown thus, ¼ inch, with great regularity of style, and he once ordered the correction of a full-size drawing of part of a Bissel truck because a piece which was correctly dimensioned to 24 inches actually scaled 1-64 inch from truth. The art of drawing nicely is not of particular value to-day in an engineer's office.

Every establishment may be said to possess the kind of draftsmen it deserves. There are too many places where he is expected to lie prone upon his board all day. Such a position is simply ridiculous; it wastes room, impairs the man physically, and is useless. With a little practice any draftsman can acquire facility in working on a vertical board where he can stand upright or use a stool and suffer less in his eyes and none in his chest.

In the old days there was constant rivalry and ill feeling between the drafting office and the pattern shop and machine shop. Such conditions were due to sheer ignorance on the part of the draftsman as to the limits of the machines in the shops, or to indifference resulting from his acting up to the official ordering of his status—that he had no business with the shops.

In a small establishment the draftsman is usually the engineer; he gets out all the plans, supervises construction in the shop and the erection outside, orders every scrap of material and gets out estimates for new work. Now if this man and his methods be taken as a starting point for the organization of a large shop, the engineering department—a wider and better term than "drawing office"—might be placed on a sound footing. When an order is to be executed, it should be left to the drawing office to decide upon the method and materials of construction, what existing drawings and patterns can be utilized, and what stock shall be ordered outside. All steel, bolts, plates or other material kept in stock should be ordered under the supervision of this department.

The present very usual system of getting out estimates for new work in an estimating department quite distinct from the engineering department, is wrong. This estimating should be done by the engineering department which ought to be the intelligence bureau of the establishment, to which all information should be sent, and from which the orders should emanate in respect to the use and purchase of materials and the general methods of construction. The keeping of time costs should come under this department by which also the piece work prices should be established. If all of these duties were organized into one department with one head, friction and red tape would be avoided and there would be harmony between the various branches of the work.

The familiar saying that there are no old draftsmen, is very true. The position is not what the intelligence and training of its best members entitle it to be, and if men are not killed off by the prone position, they leave the drawing board for other work. Better management would place such other position very often within the radius of the engineering department.

A HIGH-DROP TEST OF AN ELEVATOR SAFETY AIR CUSHION.

Engineering News, October 9, p. 295.

A test of an air cushion installed at the foot of the elevator shaft in the Philadelphia City Hall tower was made on September 29. The tower of the Philadelphia City Hall attains the greatest height of any building ever erected. It is 500 feet from the pavement to the base of the statue of William Penn, which surmounts the tower. An elevator in the tower carries visitors from the upper floor of the building to a point just below the base of the Penn statue.

The test consisted in letting the regular passenger elevator car, weighing about 2,500 pounds, drop from the top of the shaft, a free fall of 290 feet, before entering the well-like chamber 75 feet in depth called the air cushion. In the car were a lighted lantern, six rats, 50 incandescent light bulbs, and several dozen eggs. At the appointed time the car was cut loose, and four seconds later it shot like a flash out of sight into the air cushion. Two seconds afterward there was a cannon-like report, accompanying the escape of the suddenly compressed air through the valves. The sliding steel door of the air cushion chamber was then drawn back, and inspection showed that while the lantern was upset, and a few of the eggs were broken, the rats were unscathed save for a bath of kerosene oil, and the incandescent bulbs were unbroken. The elevator car appeared to be uninjured. The test is a remarkable one in that the total fall, 365 feet, exceeded by 65 feet any previous test. The velocity of the car upon entering the air chamber after a free fall of 290 feet, neglecting air and guide friction, was about 136 feet a second, or nearly 93 miles an hour. A 2,500-pound car after falling 365 feet, friction neglected, would possess 912,500 feet pounds energy; and if this energy was overcome by opposing a uniform resistance during the 75 feet of fall in the air cushion, its necessary resistance would be more than 12,000 pounds. The area of the car floor was approximately $5 \times 6 = 30$ square feet, so that the pressure upon the floor under the conditions assumed would be 400 pounds per square foot, or about 3 pounds per square inch. The maximum pressure was, of course, much greater than this, probably more than double, for the pressure starting at zero increased as the car descended until a maximum was reached. A 150-pound man under similar conditions of uniform retardation would experience an upward pressure of 720 pounds upon the soles of his feet, and probably not less than double, or say 1,500 pounds at the moment of stopping, while the pressure upon the hip joints would be about two-thirds that on the feet. A Sandow would readily sustain such a load without weakening at the hips or knees, but an ordinary man would almost surely collapse, although, of course, with injurious results by no means comparable to those that would follow a free fall of much less height. Mr. F. T. Ellithorpe, president of the Ellithorpe Safety Air Cushion Co., has himself many times dropped six stories without the least injury.

Relative to the egg as a means for testing the effect of the sudden stopping of an elevator car, *Engineering News* has several comments to make. In one series of tests upon the strength of eggs it was found that to crush an egg, placed between two flat boards, a pressure of 4 1-3 pounds was required, or 38 times the weight of the egg. Another series showed that, with the major axis set horizontal, the average crushing force was 12.2 pounds, or 97.6 times the weight of the egg. Still another series with the axis vertical gave 18.1 pounds, or 144.8 times the weight of the egg.

From the results of these tests it is quite evident that, provided no jar took place, an egg would stand a drop in an elevator car falling a distance of at least 38 times the depth of the air cushion and possibly of 95 to 145 times the depth of the air cushion, assuming a uniform retardation in the air cushion. In the 365-foot fall in the Philadelphia City Hall tower where the ratio of air cushion depth to total drop is about one to five, it is manifest that the few eggs which broke were broken by jar at the time the car struck the bottom, and not by pressure developed by their inertia.

While pressure developed by inertia would not crack the eggs, it would, as we have shown, cause a man to feel as if he literally weighed a ton, and might result in serious injury.

The egg test is, therefore, very unsatisfactory, as proof of the effectiveness of the air cushion as a safety device. The fall of animals in the car without injury is much more convincing.

In proportioning the air cushion it has been found necessary to make its depth from 1-6 to ¼, usually 1-5, the maximum possible drop of the elevator car. The sides of the air cushion chamber in the Philadelphia City Hall tower are of 5-16 sheet steel, stiffened with horizontal 5-inch I-beams, 19 inches c. to c. At the bottom is a heavy sliding steel door which is, of course, closed after the entrance of passengers into the car. There is a clearance of about ½ inch between the elevator car and the sides of the air cushion. An air escape vent is provided in one side of the air cushion and is triangular in shape. Its base, 4 inches wide, is located at the top of the air cushion, and its vertex is 35 feet below. Fifteen feet below the vertex of the escape vent is an escape valve having a circular opening 15 inches in diameter, and 10 feet from the bottom of the air cushion is another similar escape valve. The springs of the valve are so proportioned that at a pressure of about 3 pounds per square inch on the valve surface it will begin to open, and at 9 pounds per square inch the valve will have reached its maximum opening. Near the bottom of the air cushion is a check-valve which permits air to flow inward and prevents the formation of a vacuum under the car when it begins its ascent.

Four ordinary compound elevator springs are provided at the bottom of the air cushion to act as bumpers. The springs are about 5½ inches diameter, 16 inches high and susceptible of a 7-inch compression.

It will be evident that in case the car should fall into the air cushion from some point below the top of the shaft and the valves were the only means of escape, the car would be stopped before it reached the bottom of the air cushion or more quickly than necessary. As actually installed, however, there is a narrow air space all round the sides of the car between it and the walls of the chamber and the air escapes here as well as through the air valves in case a car falls into the cushion.

SPUR GEAR PLANER.

A MACHINE FOR PLANING LARGE SPUR GEARS BY THE USE OF A SINGLE-POINTED TOOL AND TEMPLETS.

The Newton Machine Tool Works, of Philadelphia, have recently furnished the R. D. Nuttall Co. with a gear cutting machine of unusual capacity and embodying many new and interesting features. While the operation of the machine is similar to that employed in some of the bevel gear shapers, this is an original application of the principle to the formation of spur gears. A good general idea of the machine is gained from the half-tone, which was taken before the machine left the shop. When in place, the top of the dividing table will be nearly flush with the shop floor and most of the indexing mechanism will be below the floor line. The gear, lying flat upon the dividing table, is accurately spaced around by the dividing mechanism shown at the left of the cut, and the teeth are shaped to templets by a tool carried in the vertical slotter. This slotter has a stroke of five feet and is driven by a spiral gear connected to the bevel gearing shown on the countershaft. The countershaft itself is driven by a motor enclosed within the column. The vertical column can be moved in and out to any desired position on the extension bed and will accommodate gears up to 30 feet in diameter. If a greater capacity was required, the bed could be extended indefinitely to take any size of gear.

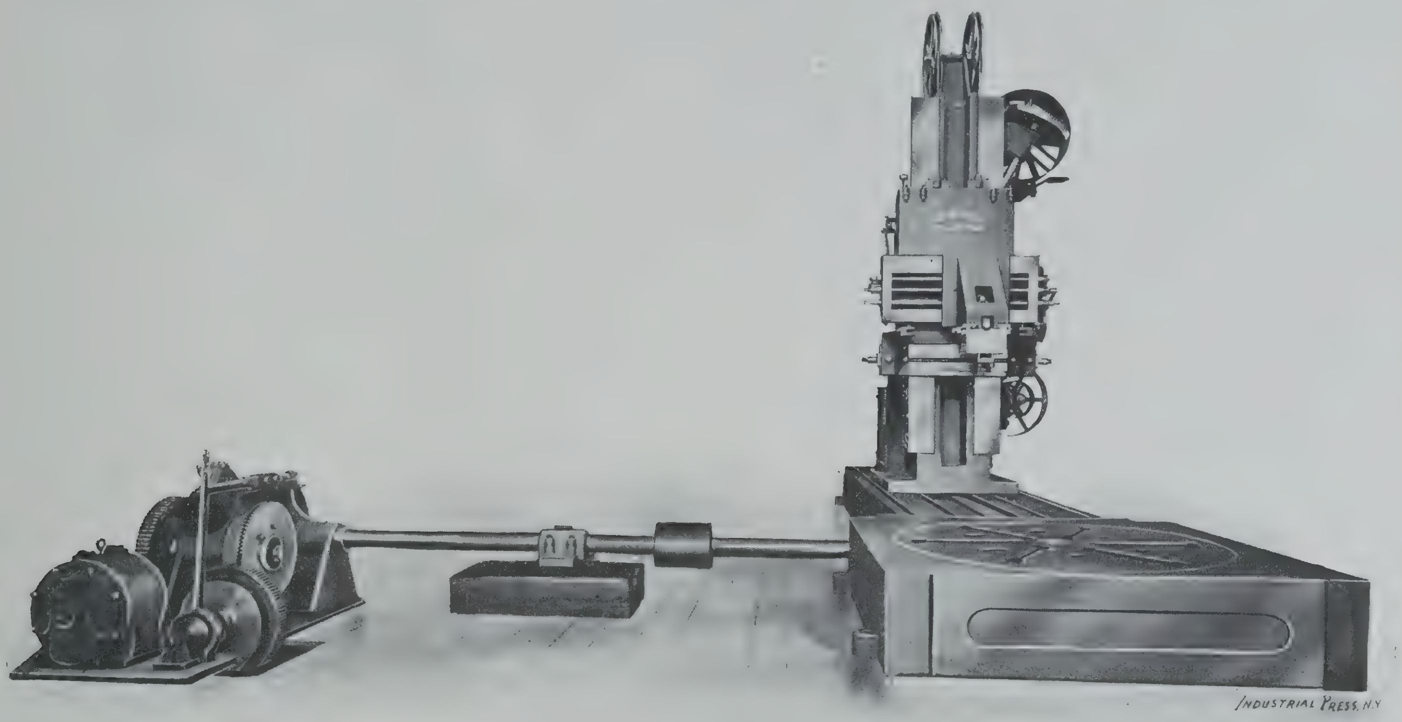


Fig. 1 Spur Gear Planer.

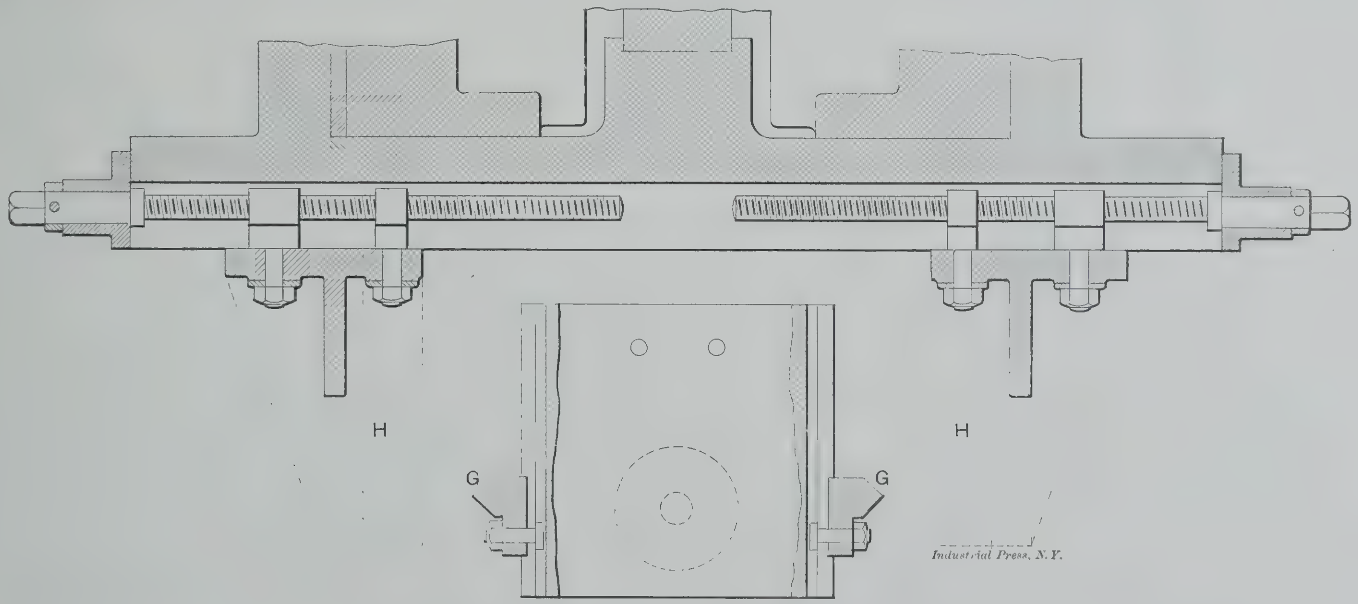


Fig. 2. Section through Guides and Templet Holders.

Figs. 3 and 4 show a section through the tool apron, or saddle, and the mechanism by which the tool is fed. As the saddle is raised and lowered the star wheel *A* is revolved by engaging with the pins *B B*. During the upward stroke no motion is produced, owing to the star wheel working on a ratchet, but as soon as the apron begins to descend, the pin gear, operating through the feed gears, causes the screw *C* to revolve and thereby feed the apron across the face of the column. With the feed gears *D* and *E*, shown in Fig. 4, in use, the apron would be fed to the right, but if these are removed and the combination shown in Fig. 3 substituted, the introduction of the extra gear *F* causes the apron to be fed to the left. Upon either side of the apron are the steel points *G G*, Fig. 2, and as the carriage is fed to one side or the other, these points come in contact with the templets which are held in the templet holders *H H*. This guides the movement of the tool to conform with the shape of the templet. As the revolution of the star wheel would have a tendency to feed the apron farther than the templet allows, a friction clutch, *I* in Fig. 5, on the star wheel shaft allows the feed to slip as soon as the point *G* touches the templet.

While the head is being fed crosswise, the tappet *J*, striking against the top of the lug *K*, revolves the gears *L*, *M* and *N*, and then through the chain of bevel gears *O*, *O*, *O*, the screw *P* is revolved, thus feeding the tool in the tool-post up to the work. A hinge and spring mechanism on the tool-post allows the tool to spring downward on the return or upward stroke.

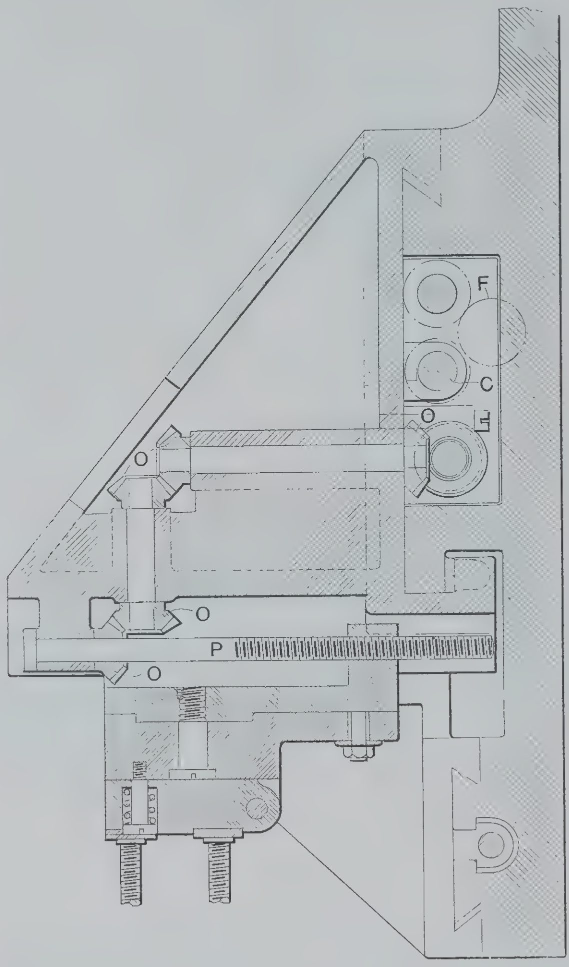


Fig. 3. Section through Tool Apron.

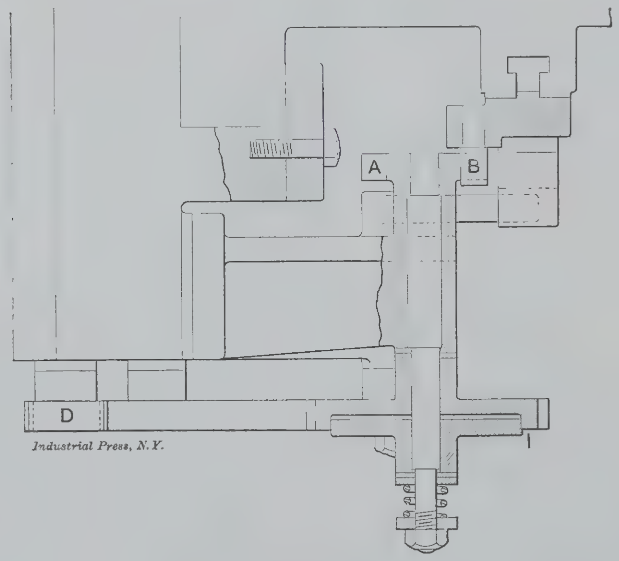


Fig. 5. Section through Star Wheel and Friction Clutch.

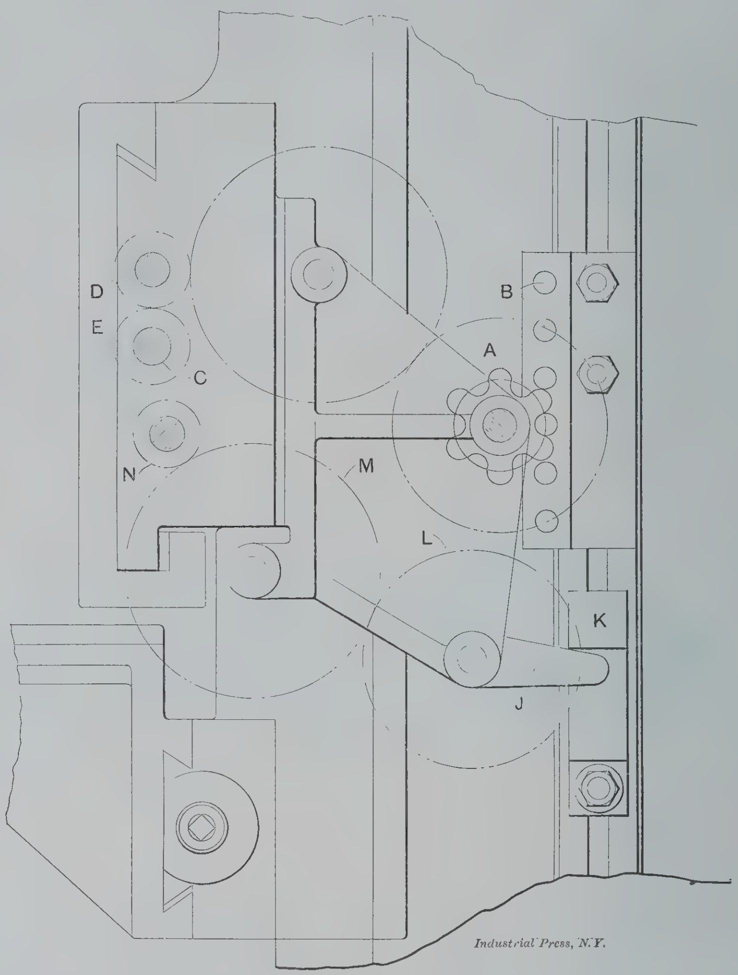


Fig. 4. Feed Mechanism.

A section through the dividing table is shown in Fig. 6. This table is, in effect, the upper side of a large worm gear which is driven by a worm on the shaft *P*. Fig. 7 shows the indexing mechanism for revolving this table. The motor having been started, the plunger *Q* is raised by means of the lever *R* and this leaves the gear *S* free to rotate. The friction lever *T* is now thrown over, putting the friction clutch in mesh, and the worm wheel *S* then revolves until checked at the end of a complete revolution by the plunger *Q*, which has by this time reached its former position at the bottom of the slot, thus preventing further rotation of the wheel *S*. The friction clutch then slips and the motor is stopped. Motion is transmitted from the worm *S* to the worm shaft *P* through the intermediate gears *U* and *V*, the sizes of which are varied to give any desired divisions to the revolution of the gear that is being cut.

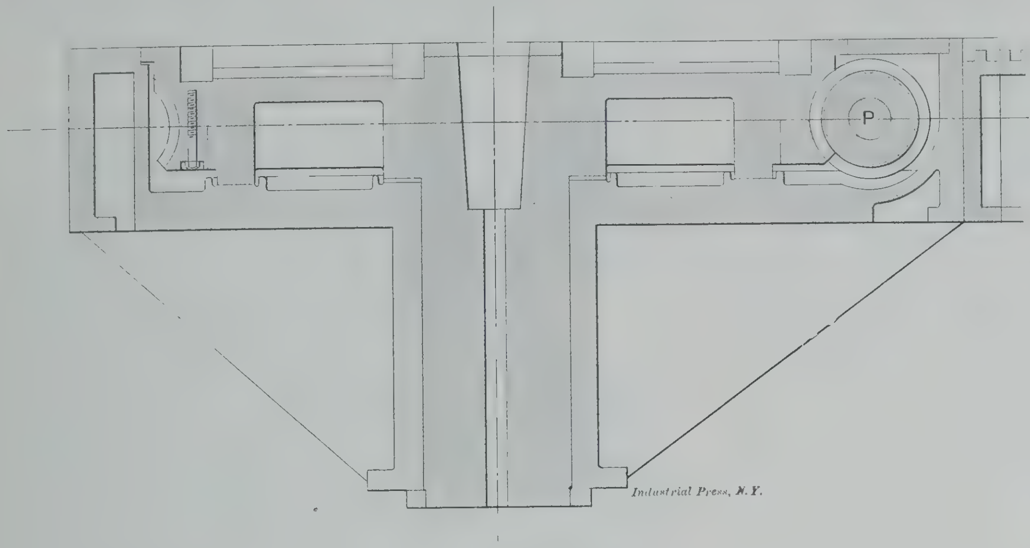
When internal gears are cut the vertical column is transferred to the dividing table, the internal gear remains stationary, and the slotting machine itself is indexed around to each tooth. When completed, this machine was tested by means of a transit placed on the dividing head. This was sighted on a point about 40 feet distant so as to multiply the error, which proved to be almost imperceptible.

* * *

NEW INDUSTRIAL CENTER.

The plants of the affiliated Westinghouse companies, Pittsburg, have become so extensive that there is little available room at their present locations for future building extensions. To provide for future growth it was necessary to go outside of the city limits and a new industrial center has been opened up about 17 miles east of Pittsburg. The new settlement is on the Pennsylvania Railroad and is to be known as Trafford City, where extensive factory sites have been laid out and every provision made for a comfortable and healthful residence section for the employees. The manufacturing plants will be located on a fairly level area between the Pennsylvania Railroad and the residence portion of the city, which will be reached from the railway station by a steel viaduct 1,100 feet long. The residence district has been laid out upon hillsides and on a generally level plateau, high enough above the factory sites to render it free from smoke and dirt. The city consists of two oblong areas, one of which is about ½ mile by 1-5 mile and the other ½ mile by 1-7 mile, the two areas meeting in such a way as to form a reversed letter "L," the corner of which is the most northerly part. The town has been laid off into about 800 building lots, each with an average frontage of about 30 feet and a depth of 100 feet.

In addition to this, space has been left for six parks. The new town is connected with Pittsburg both by the Pennsylvania Railroad and by street railroad.



Industrial Press, N.Y.

Fig. 6. Section through Dividing Table of Spur Gear Planer.

The factory site, located in a bend of Turtle Creek, provides room for nine factory buildings, each about 200 feet by 800 feet. A system of railway yards and tracks serving this area has been laid out in a very thorough manner, providing a track alongside of each building and transversely through each end. The storage tracks, in connection with this, occupy an area of about 300 feet by 200 feet.

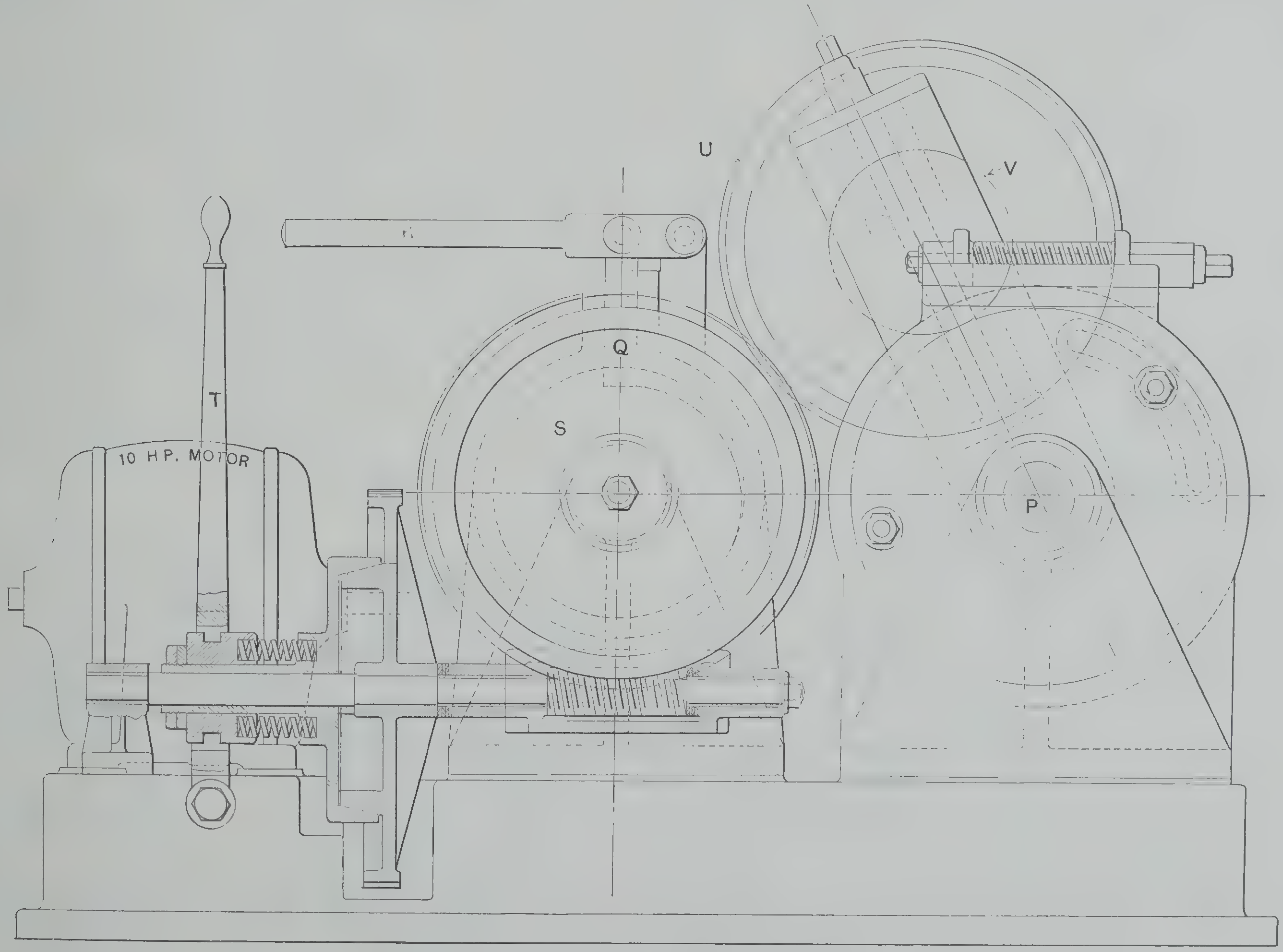


Fig. 7. Indexing Mechanism of Spur Gear Planer.

The first of the Westinghouse companies to erect buildings in the new city is the Westinghouse Foundry Co., which is putting up an extensive and model foundry plant and pattern shop. The immediate necessity for this comes from the increase in the engine and turbine business of the Westinghouse Machine Co. The pattern making and storage building is to be of steel and brick, 605 feet long and 80 feet wide. The pattern shop occupies two floors at one end of this building, the second floor being suspended from the roof trusses in order that the first story may be free from columns. The other end of the building is to be used for pattern storage and will have three floors. The foundations are of concrete and the superstructure of steel and brick. The foundation of the ground floor is made up of 8 inches of concrete into which the floor sleepers are bedded and on top of these is a layer of 2-inch maple flooring. The upper floors in both the pattern shop and storage building are supported on steel beams and steel girders, and are made up of 3-inch yellow pine flooring. The roof purlins are steel I beams spaced 8 feet center to center, and covered with 3-inch roof sheeting which is covered with slate.

The foundry building is 611 by 184 feet, and as in the case of the pattern shop, the foundations are of concrete and the superstructure of steel and brick. The foundry is divided transversely into three bays, the center bay being 80 feet between centers of columns and having runways for electric traveling cranes of 150 tons lifting capacity. The two side bays are 50 feet wide and have runways for 50-ton cranes. At one side of the foundry building runways are provided for yard traveling cranes of 100-foot span and a lifting capacity of 75 tons.

At the middle of one of the side bays, where the cupolas are located, is a charging floor about 50 feet square, constructed entirely of steel. The melting equipment of the foundry will consist of two air furnaces, each having a capacity of 30 tons, and three cupolas capable of melting 18 tons per hour each. This will enable a casting weighing as much as 100 tons to be easily poured and the casting can afterwards be lifted out of the sand by one of the 150-ton traveling cranes.

LETTERS UPON PRACTICAL SUBJECTS.

REGARDING LETTERS UPON PRACTICAL SUBJECTS.

Editor MACHINERY:

It is a noticeable fact that among practical mechanics, those who work at the bench, those who stand day after day at the machines, and those who as foremen have the active direction of everyday work, the features of a mechanical publication which are intended to give "the greatest good to the greatest number" are more or less misunderstood.

The "letters on practical subjects" are generally from men of ripe experience who endeavor to write on such matters as may be useful to many of the younger mechanics who are ambitious to profit by the experience of their elders, as well as to "find out things for themselves." A letter may sometimes seem to have been written to fill up space, when in reality nothing was farther from the author's thoughts. To another reader the same letter may prove to be of the greatest value.

Those who write these letters usually have something to say worth reading by a large number of people. They do not aim to write of matters absolutely *new*, or of subjects upon which no one has ever written before. Very few things are really new. Solomon said there was "no new thing under the sun." But there are a great many things learned by experience that are of considerable benefit to younger students and mechanics.

We often hear the remark, by experienced men in the shop: "Why, I see lots of things in that paper about my business that I knew twenty years ago; I don't see anything new in that and never thought anyone would think of writing about such a simple thing."

The good man forgets that while many of these things are not new to *him*, there are hundreds of young men in the business to whom they *are* new, and who gladly avail themselves of the opportunity thus afforded to obtain new ideas. The articles were not written for the older men who *know*, but for the younger men who do *not* know.

The older and more experienced man might as well say to the younger, "What is the use of studying school books? We knew all about the subjects in them years ago." Certainly. But there are thousands of young persons who do not know these things and must learn them. The school teacher might as well say: "Everybody knows the things I teach, why should I go on teaching the same things year after year?" Simply because *everyone* does not know these things.

It would seem to be the duty of those who have, through education and experience, learned of these special matters pertaining to their business or profession, to "pass along" the information to the many younger persons who have not had their experience, and to many who have not had their opportunities.

And it would seem to be a most worthy ambition on the part of the editors of mechanical papers to try to teach practical subjects to young mechanics and thus extend "the greatest good to the greatest number," as well as to record the new inventions and discoveries, and to publish wise dissertations on deep and erudite scientific subjects.

OSCAR E. PERRIGO.

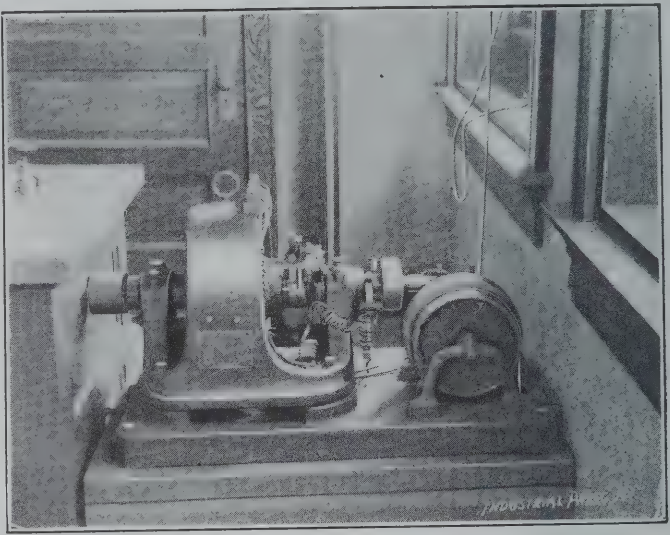
AN AUTOMATIC ELECTRIC CURTAIN HOIST.

Editor MACHINERY:

In every college lecture room as well as in many high schools and institutes the electric stereopticon is frequently employed in connection with the regular day courses of work. It is then necessary to darken the windows by means of shades, as well as to draw down a prepared white screen for illustrative purposes.

The accompanying illustration shows a very unique electrical hoisting apparatus which is used for drawing down the shades and the stereopticon screen at the same time by simply pressing a button or turning a switch. The apparatus was devised by Chas. W. Carman, of Chicago, formerly the professor of physics at the Lewis Institute.

This automatic electrical device makes it possible for the operator at the lantern to open all the opaque shades of the lecture room or laboratory in an instant by a special switch close at hand. The same device raises the screen out of the way while another daylight demonstration or lecture is taking up a portion of the time. The curtains are all raised or lowered in less than half a minute from the time the switch is closed, and when fully opened or closed the mechanism is automatically cut out of circuit. The operator after manipulating the switch may therefore immediately give his attention to other work.



Electric Curtain and Screen Hoist.

The drum is connected to the motor through a worm gear and a magnetic clutch. It is a reversible motor and by means of a double-throw switch is operated in one direction or the other, depending upon whether the curtains are to be raised or lowered. The limit stop provided breaks the circuit through the motor armature and the magnetic clutch, and changes the connections when the curtains are in their extreme position. The magnetic clutch ceases to act and the curtains are held in position while the armature comes to rest after its momentum is overcome.

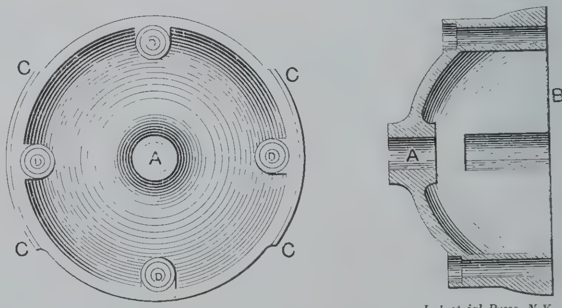
The stereopticon screen is connected to the drum by a rope and the various shades about the room are connected by cords through pulleys to the rope which extends around the room below the windows. A weight is arranged at the end of the rope which keeps it taut regardless of the action of the curtain rollers. There are two portions on the drum, one of greater diameter than the other, and the curtain roller cords are connected to one and the stereopticon screen rope to the other so as to provide for the different ranges of travel. The motor used is of the multipolar direct current type, as noted in the accompanying view.

Buffalo, N. Y. FRANK C. PERKINS.

TOOLS FOR MACHINING A SPECIAL CASTING.

Editor MACHINERY:

The hood-shaped casting shown in Fig. 1 formed part of an electrical appliance which was being manufactured in large numbers and, as it is a characteristic piece of duplicate work, the method employed in its production may prove of interest to MACHINERY readers.

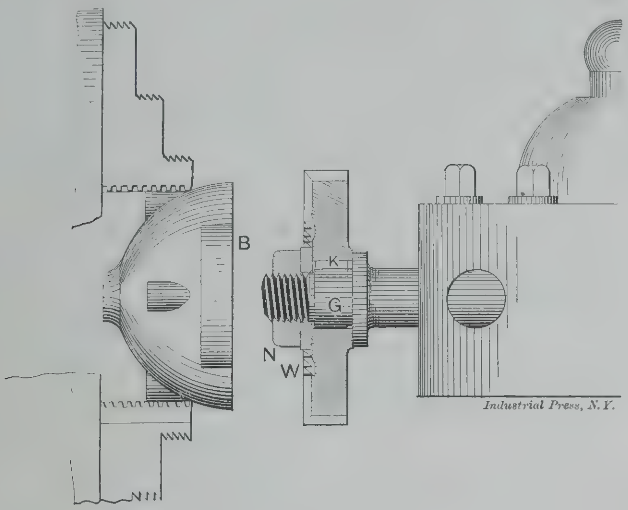


Industrial Press, N. Y.

Fig. 1. The Casting to be Machined.

The operations necessary for machining this casting were:

First, to drill and ream the ½-inch hole *A;* second, face the base *B;* third, finish the circular portions *C C* to given diameter and taper; and finally, to drill the ¼-inch holes through the center of each of the four posts *D D*. The first and second operations were both performed on a turret lathe with the casting held in a four-jaw chuck, as shown in Fig. 2. The hole *A* was first bored with the usual turret boring tool and reamed to size with a floating reamer. The work was then driven slowly, by throwing in the back gears; and the second operation, that of facing the base *B*, was performed by the use of a large face milling cutter, placed on an arbor which was held in the turret head, as shown in Fig. 2. This cutter was of the ordinary type of facing cutter except that the teeth, on the facing side, were staggered to prevent chatter. The cutter, which was driven by the key *K*, was held in place on the arbor by the nut *N* and the washer *W*.

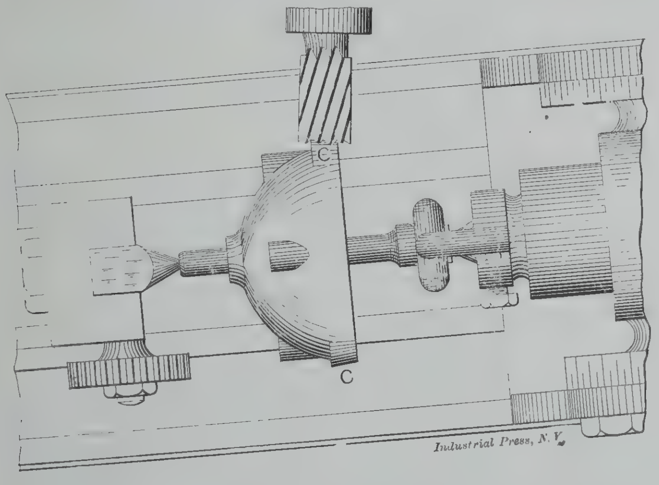


Industrial Press, N.Y.

Fig. 2. Facing the Base.

With this cutter it was possible to machine a large number of castings before it required to be ground.

The third operation, that of finishing the circular taper surfaces *C C*, was accomplished as shown in Fig. 3 by the use of an end mill in a universal milling machine. The work was held on an arbor between the tail and dividing-head centers and the swivel carriage moved around until the table and arbor stood at the desired angle with the face of the milling cutter. After setting the work so that the desired amount of stock would be removed, the cross-feed screw was clamped, and the work fed against the cutter by revolving the dividing head by hand. For the last operation, that of drilling the holes *D D*, the jig shown in Fig. 4 was constructed. This jig was made in two parts, a body casting in which the work was located, and a lid *W*, which was hinged at one side and carried the four tool-steel bushings *R R* by means of which the holes were located and drilled.

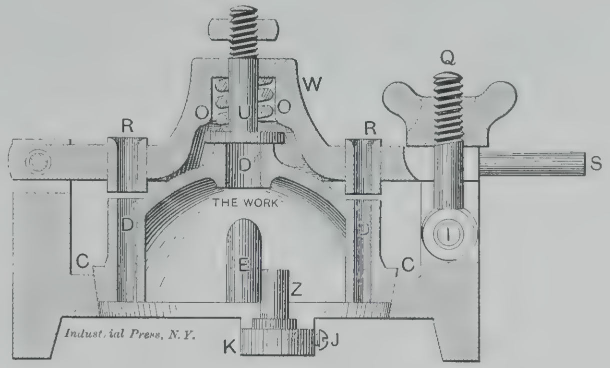


Industrial Press, N.Y.

Fig. 3. Milling the Sides.

A hinged bolt and thumb nut *Q* served to clamp the two parts together when the jig was in use.

The bottom of the body was bored out to correspond in taper and diameter with the taper surfaces of the work at *C C*. Extending inward from one side of this hole was a lug *K* in which was fitted the stop pin *Z*. The stem of this pin, where it fitted into the lug, was eccentric with the body of the pin so as to provide for adjustment, while the screw *J* locked the pin in place when the proper adjustment was attained.



Industrial Press, N.Y.

Fig. 4. Jig for Drilling.

This pin was brought against one of the inner lugs of the casting, as at *E*, and thus located the lugs in the proper position to be drilled.

When in use the swinging clamp *Q* is released and the lid *W* thrown back. The work is then slipped into the body and located within the taper seat and against the stop pin *Z*. The lid is then brought down by grasping the handle *S*, and as the spring pad *U* strikes the work the tension of the spring *O O* enables it to force it tightly down on the locating seat. The lid is then held down on the body casting with one hand, while the swinging clamp is swung up and fastened with the other. The casting is then drilled through the bushings *R R*. One of the best features of the jig is the impossibility of the chips and dirt interfering with the accurate and positive locating of the work.
Fred J. Bryon.

Brooklyn, N. Y.

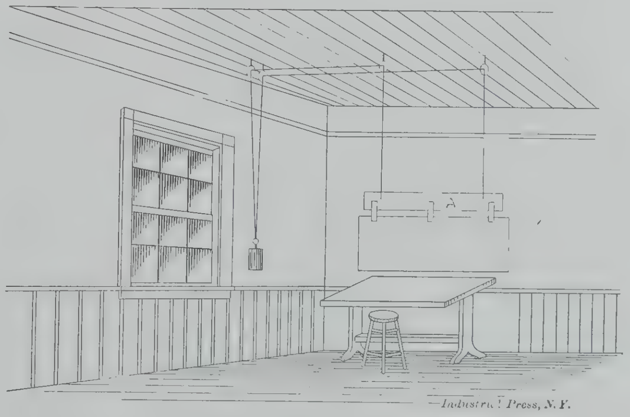
A DRAFTING-ROOM CONVENIENCE.

Editor Machinery:

How often it is that a draftsman is required to use another drawing for reference which he must continually consult, and if it is a large sized drawing it is generally kept on the consulting table beside his drawing board. This compels him to keep forever stretching to see it or constantly getting on and off his stool.

In a place where I was once employed, having much of this to do, I devised a scheme which caused some ridiculing from the boys, but which proved to be very useful as well as cheap, and it may prove of interest to some other draftsman.

The illustration will make it clear without much explanation. *A* is a pine stick ⅜ inch by 1½ inch and about 40 inches long. Onto this stick are screwed three ordinary spring clothes pins. Two strings are fastened to the stick and pass up to two screw eyes placed in the ceiling the same distance apart as the strings on the stick.



Industrial Press, N.Y.

Hanger for Reference Drawings.

Two more screw eyes are placed in the ceiling near the wall, or any out-of-the-way place, and through these the strings pass down to a weight. This holder is placed parallel to the drawing board about one inch back of it.

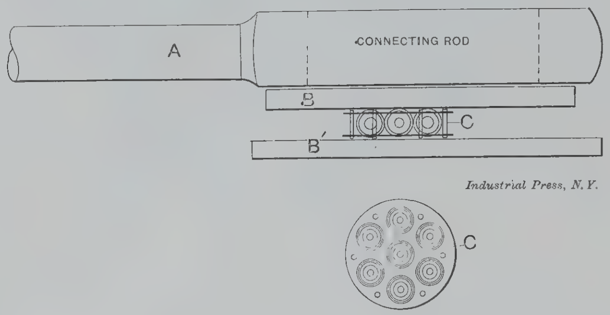
This holds the drawing where it can be easily referred to by the draftsman, and it can be easily raised or lowered to suit his convenience.

Ernest W. Duston.

BALL BEARING FOR SUPPORTING LONG WORK ON A SLOTTER.

Editor Machinery:

Recently while passing through the shops of a large concern in Philadelphia that builds blowing and high-speed engines, I noticed an application of the ball bearing to a rather unusual purpose and one that was new to me. Like many other simple things its use for the purpose is quite obvious when it is once known.



Ball Bearing Support for End of Connecting Rod.

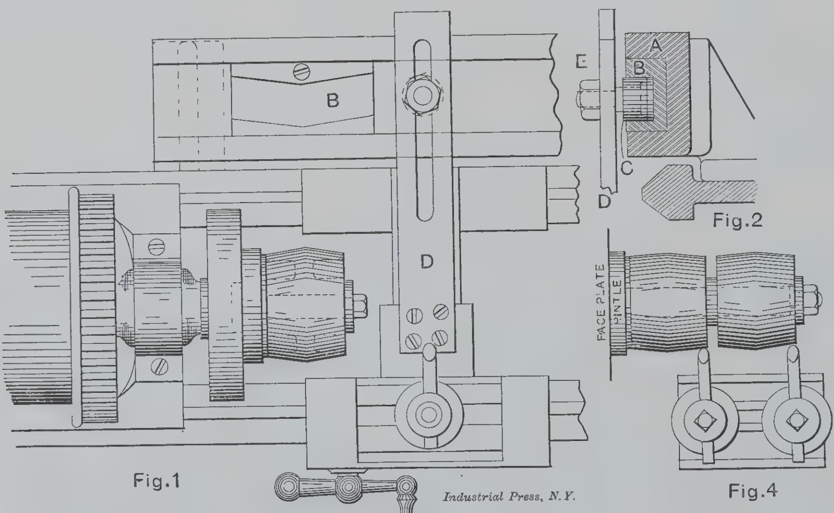
A large connecting-rod was being machined on a slotter and the ball bearing was used to support the outer end so that it was free to move in all directions with the feeds. The usual plan that I have seen followed in such cases, is to support the outer end of a long piece by a rope tackle or a chain hoist attached to an overhead support, but in some cases, as here, such an arrangement is inconvenient. The connecting-rod on the slotter was of the solid-end type, 12 or 15 feet long and weighing probably not less than 1,500 pounds. The work being done was squaring up the interior surfaces for the adjustable brasses so that the feeds were in two directions. If a roller bearing or a carriage with wheels had been used it would have been necessary to turn it one-quarter around when changing from one feed to the other. The ball bearing *C* was placed between two surface plates *B B'* under the rod *A*, as indicated in the cut. The balls were about 1½ inch diameter and were six or seven in number. They were held in a cage made of two disks of sheet iron held in proper relative position by rivets and distance pieces. The disks were, of course, perforated with holes through which the balls projected in order to bear on the plates.

Newark, N. J. F. Emerson.

TURNING PULLEYS IN THE LATHE.

Editor Machinery:

Considering the large number of excellent machines that are now made for turning pulleys it may seem a little behind the times to say anything about doing this class of work in lathes.



Lathe arranged for Turning Pulleys.

There are, however, many shops in which a large number of pulleys have to be turned, yet not enough to warrant the installation of an expensive pulley turning machine. In such shops the pulleys are turned in a lathe, the tail stock being set over to give the taper which is required to give the pulley its crown.

As this involves several objectionable features, a number of expedients have been devised whereby the pulley may be turned crowning, at the same time keeping the centers in line.

The method here described has been in use for about six years and has been very satisfactory as it is extremely simple and does the work rapidly.

A grooved rail, *A*, Fig. 2, is fastened onto the back of the lathe bed and in this groove slides the guide block *B*, in which are cut two grooves making the same angle with the center line of the lathe as it is desired that the faces of the pulley shall make with the axis. In this groove runs a roller *C*, which is fastened to the under side of the arm *D*. This arm *D* is in turn attached to the tool block. The cross feed screw is removed from the carriage so that the motion of the roller in the guide block imparts a similar motion to the tool in the tool post. The guide block *B* is clamped within the rail *A*, in such a position that when the tool is at the point of the crown of the pulley the roll will be at the apex of the groove. The tool is set by moving the tool block in and out, with the nut *E* loose, allowing the shank of the roll to slide freely through the slot in the arm *D*. The tool and guide block having been set properly, are clamped in their respective positions, and the pulley is turned in the same manner as if the face were straight. When this attachment was used to turn pulleys that had been forced on an ordinary lathe arbor it was necessary to alter the guide block for each pulley in order to bring the center of the crown coincident with the center of the pulley; so for the stock sizes of pulleys, the faceplate arbors, or pintles, were made as shown in Fig. 3. These pintles consisted of a cast iron base *F* into which was securely screwed the arbor *G*, of the same diameter as the bore of the pulley. The pulleys were held on the arbor by the washer *H* and the nut *K*, and were driven by means of the pin *L* which engaged one of the arms. The nut *K* is of such size that the distance across its corners is less than the bore of the pulley and the washer *H* has one side open at *O*. By making the nut and washer in this way, when it is desired to remove a pulley, the nut is turned only enough to release the washer which can be slipped off by the slot *O*, after which the pulley can be pulled off over the nut.

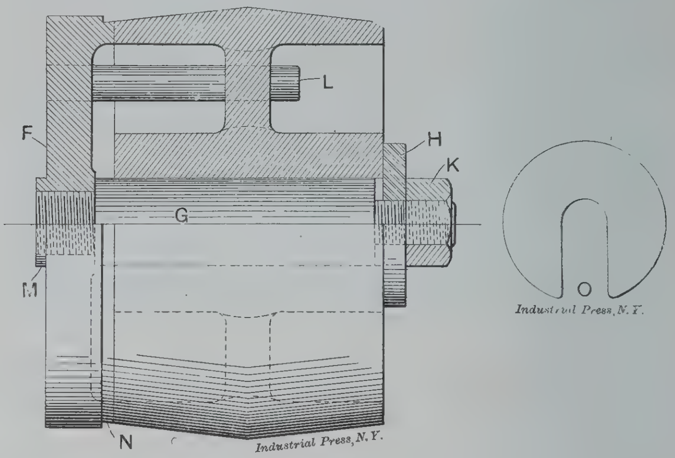


Fig. 3. Pintle for Turning Pulleys.

The pintles were held to the faceplate by two clamp bolts and were centered by the boss *M*, which fits a corresponding recess in the center of the faceplate. A little step will be noticed on the rim of the pintle at *N*. This is for setting the lathe tool and is of the same diameter as the pulley to be turned will be at the edge of the rim. This is of the greatest convenience, for in using this attachment the cut always begins at the outside edge of the pulley, and if we did not have this gage it would be necessary to calculate each time what the diameter should be at the edge in order that the pulley should have the required diameter at the crown. As it is, we have only to set our tool to the gage and we know that the pulley will have the proper crown diameter. A separate pintle must, of course, be provided for each diameter and face of pulley.

To turn a pulley with this attachment, we first set the tool to the gage on the pintle, then the carriage is run by hand, away from the pintle sufficiently to allow the pulley to be put on. After this the tool is run up to the edge of the pulley, the longitudinal feed is thrown in, and the pulley is turned, the tool feeding toward the headstock. When the turning is completed, the lathe is stopped and the pulley taken off. The carriage is then run back out of the way and the next pulley put on the pintle, the carriage brought up to the starting point, and the operation repeated. The tool having once been set for a given size need not be altered except for sharpening.

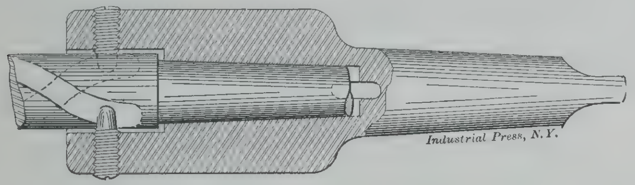
Two small pulleys may be turned at the same time by using two tools as shown in Fig. 4.

New York, N. Y. GEORGE HENRY.

HOLDER FOR BROKEN SHANK DRILLS.

Editor MACHINERY:

Like most tool-makers, I have had a great amount of trouble in trying to use drills from which the tang has been broken. These drills are too good to throw away, so I devised the socket shown in the sketch for holding them. The taper shank of the drill fits its corresponding taper hole in the socket and is thus sure of running true. After the drill is pushed into the socket the headless set-screws are screwed down into the flutes of the drill and thus keep it from turning in the socket. This arrangement works very satisfactorily and soon saves its cost in the value of the otherwise useless drills that can be used with it.



Holder for Broken Shank Drills.

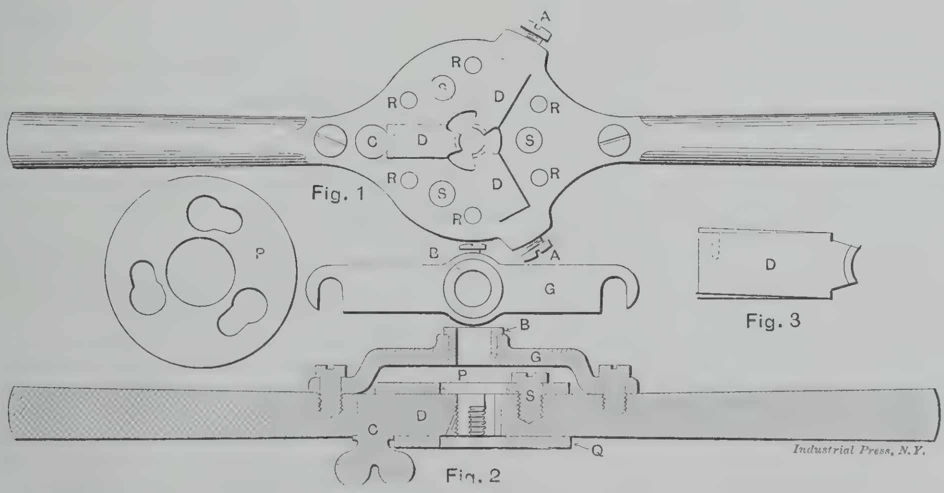
Philadelphia, Pa. FRED HARRISON.

AN ADJUSTABLE HAND THREADING DIE.

Editor MACHINERY:

The accompanying sketch shows a hand threading die, the cutters of which are backed off slightly, making it a very easy running die, and it is also provided with a way of opening the cutters to back it off of the thread that has been cut and closing them again to exactly the same size.

The stock with plate *P* removed is shown in Fig. 1 and a sectional view with all parts in position in Fig. 2.



Hand Threading Die and Die Stock.

The plate *Q* is firmly riveted to the stock by the six rivets marked *R*. The plate *P* drops over the heads of the three screws marked *S*, and after turning the narrow part of slots under these heads the screws are run down and hold the plate in position.

The cutters *D D D* are made to fit the slots in the stock, are threaded, and then tapered off on the cutting side as shown in Fig. 3 (a taper of about .006" per inch) and a thin piece of steel riveted to the opposite side with a small rivet and worked down until the cutter and wedge is the size the cutter originally was.

This throws the cutting edge in enough so that the thread following does not drag or bind on the work.

The cam *C* has a flat side and when the die is to be backed off of a thread its flat side is turned to the cutter, allowing the cutter to slide back enough for the die to run freely off the threaded bolt. It is kept in place by a small screw (not shown), the head of which is seated on the small collar beneath the butterfly head.

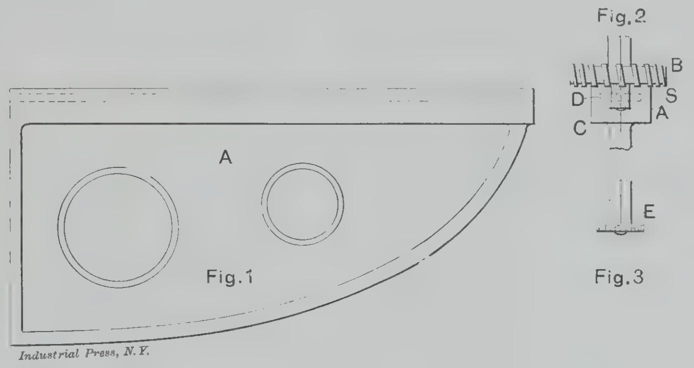
The adjusting screws *A A* are to adjust the other two cutters and need not be moved except when sizing the first thread cut. The guide *G* with its bushing *B* is plainly shown and, I think, needs no explanation. M. H. BALL.

Watervliet, N. Y.

A PROFITABLE OPERATION.

Editor MACHINERY:

The tail piece casting, *A*, Fig. 1, of the Binsse Machine Tool Co.'s boring mill, has a long undercut groove on the upper side for the feed slide to which the cutter bar is clamped. This groove was formerly machined on the planer, but at considerable trouble and expense on account of the narrowness of the undercut portions. These are squarely cut for the wings of the feed slide. Anyone having experience in planing under ledges will appreciate the difficulty of producing square accurate work with slim bent planer tools working in a narrow space. These grooves are now milled on a Brown & Sharpe No. 5 vertical milling machine which has been recently installed. They are finished in four operations, two roughing and two finishing cuts. The first operation is indicated in Fig. 2. The milling tool is a compound cutter, consisting of the surfacing cutter *B* and the grooving cutter *C*. Two of these tools are provided, one for roughing and the other for finishing. After the finishing cut has been taken, the undercut portion indicated by the dotted lines *D* is milled with the cutter *E*, Fig. 3. Two of these cutters are also provided for roughing and finishing. These cutters are made with "staggered" teeth, that is, say a tooth is located so as to cut on the upper side of the groove, then the next one on the lower side and so on. The shanks of cutters *E* are made to closely fill the groove previously milled so as to steady them sideways. The work produced in this manner is highly satisfactory, both in quality and cost. F. E. R.



Milling Tail Piece of Boring Mill.

PUNCH AND DIE MAKING.

Editor MACHINERY:

In the September number of MACHINERY Mr. Joseph V. Woodworth had an article describing the construction of a double punch and die. Now with all due respect to Mr. Woodworth, my experience as a toolmaker leads me to take exception to some parts of his method employed for constructing this die.

Mr. Woodworth states that no great care need be exercised in planing the die, as it is to be ground; but it has been my experience that it is better to plane the die carefully so as to have the top and bottom parallel. I have also found it better to bevel the sides of the die last, for by leaving the edges square it will stand squarely on edge and a surface gage can be used for laying out, which I consider much better than using a try square. In using the try square, if the diemaker tilts the beam of his square the least amount, it places the blade of the square on an angle across the face of the die.

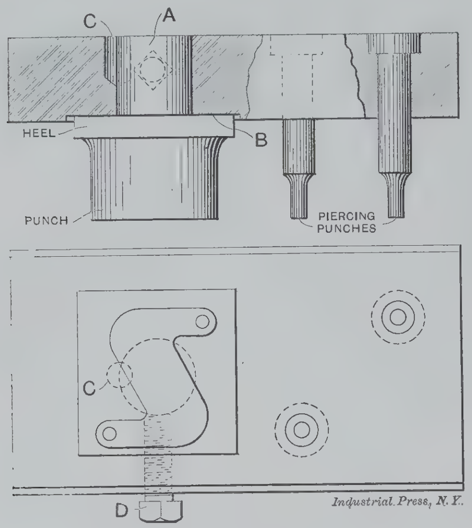


Fig. 1. Punch and Punch Plate.

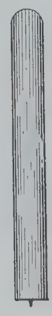


Fig. 2. Prick Punch.

For outlining the blank on the face of the die, he describes the use of a female templet formed by bending a piece of brass over the face of the die and working out the center to exactly fit the male templet. Now in Mr. Woodworth's use of a female templet he introduces several opportunities for an error. In bending his sheet brass to fit the die, an *exact* fit is necessary, and this is not an easy thing to obtain. Then consider the time required for filing an irregular shaped hole to fit a templet perfectly. Supposing that the toolmaker in filing this female templet should get the edges of the profile on a slight angle (such a thing happens quite frequently), then when he scribes the outline on the die from this templet, he is scribing an outline that is not a counterpart of the master templet. Therefore, considering the chances of error in bending, filing and scribing and the time that this requires, I would suggest doing away with the use of the female templet altogether. To do this, clamp a thin parallel—a scale does very nicely—to the face of the die. Against this parallel, place the master templet, clamp and scribe the outline. Then slide the master templet along the parallel to proper position, and transfer the piercing holes directly from it. In transferring these holes, Mr. Woodworth advises the use of a center drill which fits the holes in the male templet. In making the center drill, one turns the drill to fit the hole in the templet and points it at the same time without removing it from the lathe until it is completed. But in filing the clearance of the drill it is a very easy matter to carry the point to one side, making it run eccentric to the body of the drill. True, it will spot a hole central with the drill but the eccentric motion has a strong tendency to crawl along the face of the die, thereby changing the position of the templet. A greater objection is the undeniable chance of error when starting another drill in the place spotted, for a center drill will not allow spotting deeply, as a long point would touch the die before the body entered the templet. I very much prefer to use a piece that has been turned to fit the templet and a very small prick punch turned in the center, at same turning, as shown in Fig. 2. By placing the prick punch in the templet when it is in proper position and giving it a light tap, it will prick the face of the die sufficiently to "wiggle up," as toolmakers term it, with the center indicator.

As to the punch, Mr. Woodworth advocates machining it "so that its entire length will be the shape of the blank." I think it is much better to make it as shown in Fig. 1, the reason being that the shoulder or heel left on the punch tends to keep all the weak parts from spreading during the process of hardening. I submit the following method for aligning the punch and die as an improvement on that described by Mr. Woodworth:

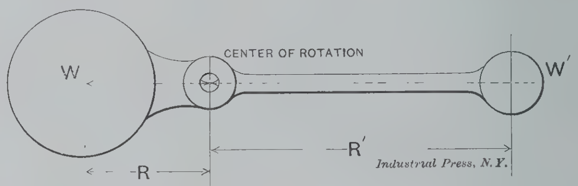
Clamp the punch plate on the face of the die and with the prick punch, shown in Fig. 2, which fits perfectly the piercing holes in the die, prick the face of the punch plate; then without disturbing the plate, scribe the outline of the blanking die upon its face. Remove the punch plate and find the approximate center of the outline scribed from the blanking die and prick punch same. Now "wiggle up" and bore the hole for the shank of the punch *A*, and at the same time face off a seat for the back of the punch at *B;* also bore the holes for the piercing punches. Make these punches as shown to fit tightly the holes in the punch plate. In making the piercing punches they should be left 1-32 inch longer than the blanking punch. Insert the two piercing punches and the blanking punch into the punch plate and fit the dowel *C* in the shank of the blanking punch. Enter the two piercing punches into the die until the face of the blanking punch rests on the face of the die; then scribe the outline of the blanking die on the face of the punch, care being taken to scribe close to the die. Remove the punch and mill as close to the line as possible, return punch to holder after beveling the edges slightly, and shear the punch, being guided by the piercing punches. Work off the stock curled up and repeat the operation until finished. If the punch is to work heavy stock, a setscrew, *D*, against the shank of the punch would be advisable.

New Haven, Conn. Frank E. Shailor.

BALANCING REVOLVING BODIES.

Editor Machinery:

Having had several discussions with mechanics of the question of the balance of unsymmetrical bodies, I have found that many have erroneous ideas on the subject. For instance, many contend that a body like that shown in the figure might be in perfect balance at one speed but not at all speeds of rotation, owing to the action of centrifugal force. I trust that the following discussion from a mathematical standpoint may help some to get the correct view of the subject.



In the figure let

W = number of pounds in larger weight.

R = number of inches from center of gravity of W to center of rotation.

W^1 = number of pounds in smaller weight.

R^1 = number of inches from center of gravity of W^1 to center of rotation.

For W and W^1 to balance each other, it is obvious that WR must equal W^1R^1, when they are at rest. Now let:

F = centrifugal force in pounds set up by W when revolving at n revolutions per second.

F′ = centrifugal force in pounds set up by W′ when revolving at n revolutions per second.

Then, of the revolving bodies balance F = F′; also

$$F = \frac{4\,\pi^2\,W n^2\,R}{g} \text{ and } F^1 = \frac{4\,\pi^2\,W^1\,n^2\,R^1}{g}$$

Therefore,

$$\frac{4\,\pi^2\,W n^2\,R}{g} = \frac{4\,\pi^2\,W^1\,n^2\,R^1}{g}$$

and cancelling the equal terms we find $WR = W^1R^1$. So we see that a perfect standing balance is a perfect running balance at all speeds, for the weight on one side multiplied by its radius always equals the weight on the other side multiplied by its radius and the speed factor drops out entirely.

It will be seen from the foregoing equations that the centrifugal force varies as the square of the speed; hence if the speed is doubled the centrifugal force is increased four times.

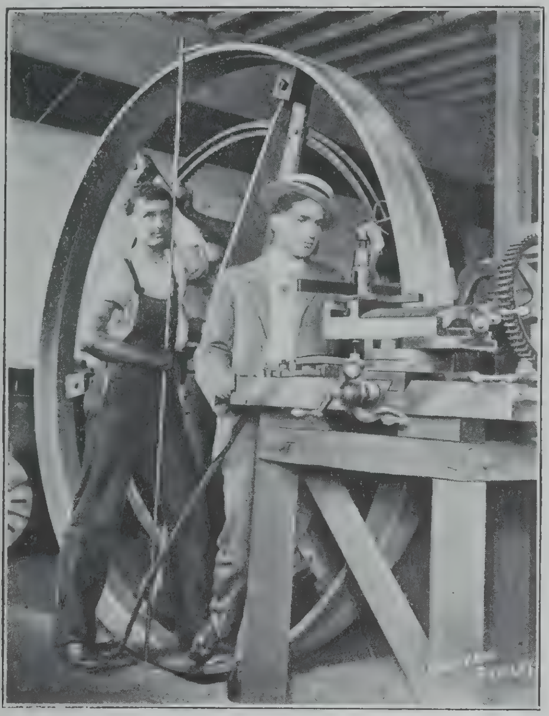
If we suppose the difference between the centrifugal force of W and W^1 to be very slight, when revolving at 100 revolutions per minute they would appear to balance. If now they were revolved 500 revolutions they would at once be seen to be out of balance, since the difference in centrifugal force would be 25 times as great as at the former speed.

Grand Rapids, Mich. G. E. Miles.

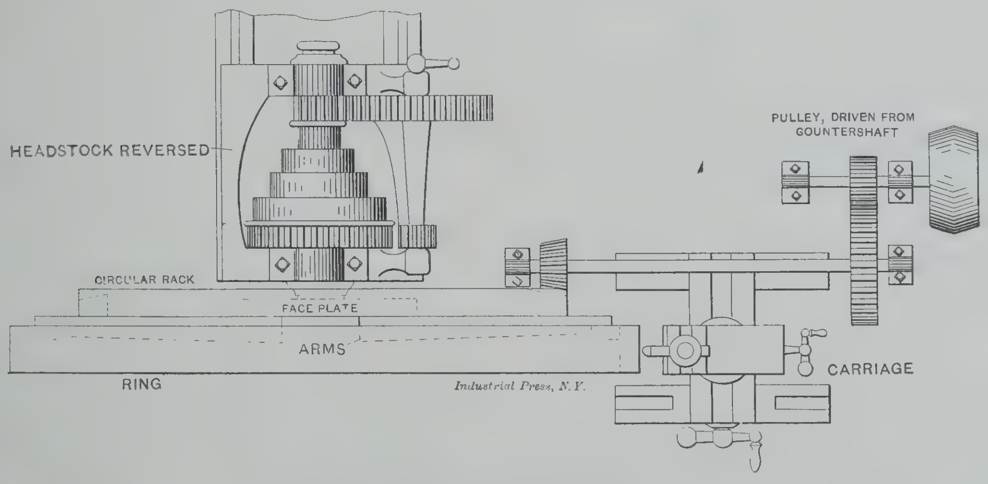
TURNING NINETY-INCH PISTON RINGS.

Editor Machinery:

In the works where I am employed we recently had occasion to re-bore a compress cylinder 90 inches in diameter and make new rings for the same. The re-boring was easily accomplished with a 6-inch bar pulled with a rack, but when it came to turning the rings we were somewhat puzzled, as the largest lathe in the shop would swing but 32 inches. The manner in which we finally accomplished the job will be clearly seen in the accompanying photograph and sketch. We reversed the headstock of the lathe so that the faceplate would overhang the end of the bed and to the faceplate we bolted six ribs or arms. Near the outer end of these arms and concentric with the center of the lathe we bolted a circular rack. The rings were cast with six lugs which were bolted to the ends of the ribs. The ring was driven by a gear and pinion arrangement clearly shown in the sketch. The carriage was mounted upon a wooden frame and the tool fed by hand. With this rig we were able to turn two rings, each 3 inches wide and 90¼ inches in diameter, in 30 hours.



Turning the Rings.



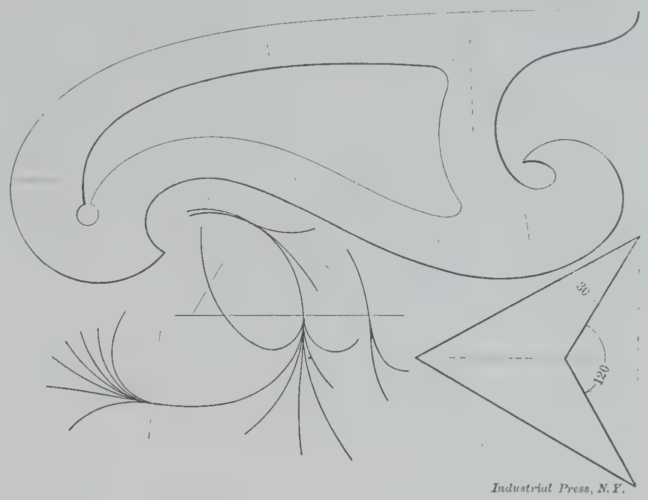
Arrangement for Driving the Casting.

Dallas, Texas. Otto P. Downing.

DRAWING COMPOUND CURVES.

Editor Machinery:

In making up double curves or reverse curves by means of compasses, or the so-called "French curve" templets, it must be remembered, that no two curves can join neatly except at points where their tangents are common, and that any two or more curves can be joined end to end gracefully, if they be tangent to the same line. This is true of two or more convex or of two or more concave curves, or of one or more convex and one or more concave.



Compound Curves and Isometric Triangle.

To facilitate this work it is well to draw at various points on the templets, lines perpendicular to the tangents thereto and in laying down compound curves to see to it that these perpendiculars coincide.

I send herewith an outline of such a templet with some perpendiculars marked thereon; also some "traces" made in accordance with this system.

Machine frames made with outlines which do not sweep into each other on this plan will be neither so strong nor so graceful as where the curves have common tangents at their points of meeting.

As in isometric drawing the main axes which are not vertical are at 30 degrees to the horizontal, there may be used to advantage to facilitate rapid drawing in of the inclined lines such an "arrow-head" device as is shown in sketch. From the base of an equilateral triangle (preferably of transparent celluloid) there is cut out an isosceles one of 120 degrees apex, care being taken to keep the sides of the large triangle equal. The piece cut out may also be finished and used for angles of 30 degrees.

Another way of making the same thing is to cut two equal isosceles triangles of 120 degrees, glue them together at the short sides, and strengthen the joint with a double dovetail or double clover-leaf key.

Robert Grimshaw.
Hanover, Germany.

GET-AT-ABLE BOILERS.

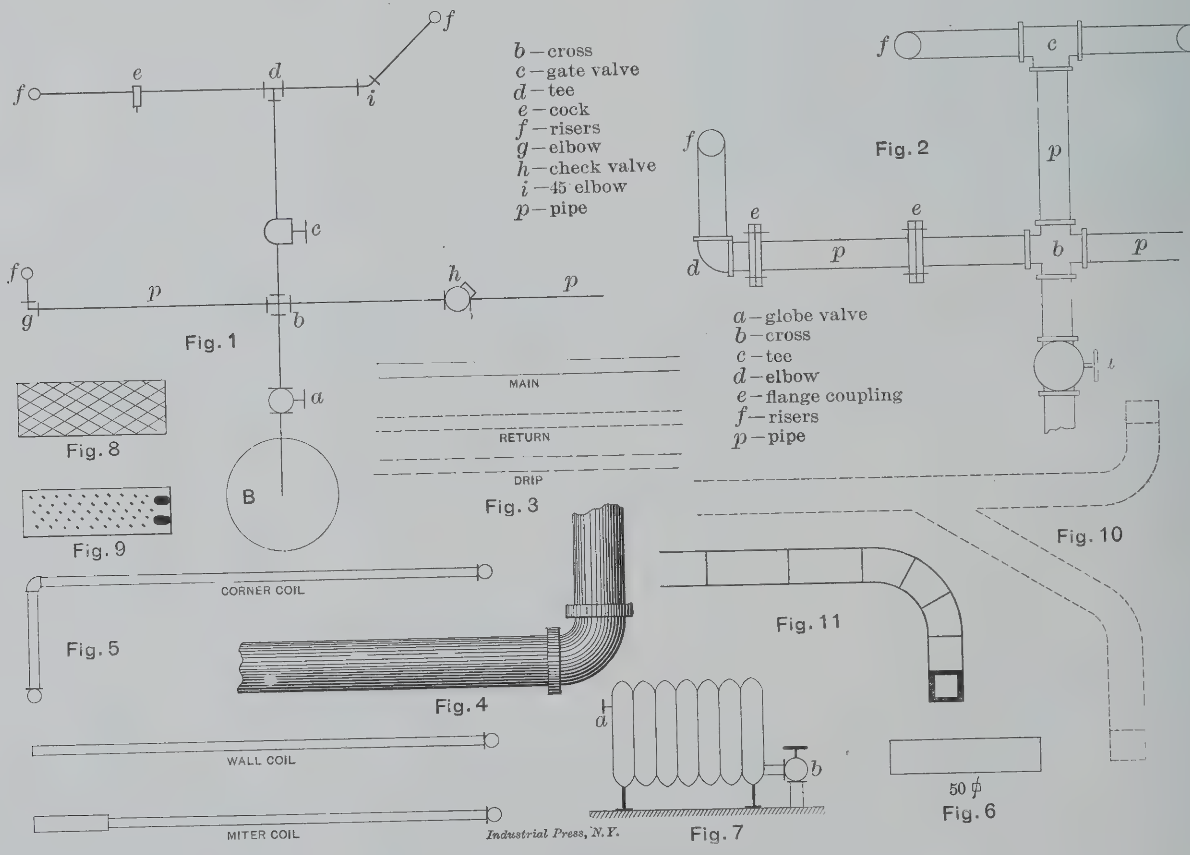
Editor Machinery:

It is a good maxim in any kind of construction that hidden work is apt to be, or become bad. It may start out good, when the maker is competent and honest; but sooner or later if you cannot get at it to inspect it, and repair it, there will be trouble. How few things give out when you can see where they are "going?" Somewhere back or below or within, where the eye cannot reach or where light never penetrates, there is a leak or a crack, or something wrong. A boiler, being an affair which may be highly dangerous, should be of a kind which will permit a man of moderate size not only to look it all over but to go all through it. His eyes should be able to see, his hand to feel every portion. If possible there should be room for a hammer to strike every part, in order to determine whether it gives a ring or not, and whether or not things are right. The boiler that you can get into, under and around is, other things considered as equal, more desirable than one which cannot be got at. There is a great deal of human nature in mankind, and the average man is not going to break his back and strain and twist his neck and break his shins crawling under and over and by obstructions more or less sharp, hard and dirty. If he owns the boiler, he will do all of this perhaps under a sense of duty to himself; but remembering that, after all, the duty is principally due to himself, he will postpone paying it until the last possible moment. Sometimes he waits until the "last horn blows," and the last horn is an explosion.

Accessibility is a source of economy, because the boiler that can be got at easily will be kept clean, and the clean boiler will make steam more cheaply than a dirty one. The accessible boiler is more safe, other things being equal, than the one which cannot be got at without a great deal of trouble. Eternal vigilance is the price of safety no less than of liberty.

The boiler which can be got at will be less likely than any other to break down suddenly and stop a whole establishment. And in these days the stoppage of steam supply may throw out of work hundreds and even thousands of hands; for steam is not only the source of power, but also the heating agent.

All things being considered, and considered in their true light and in their true weight, it pays in every way to provide in a boiler a fair degree of accessibility; and the boiler which is get-at-able is the one which can be trusted, day in and day out, to give better money's worth and cause less anxiety than the one which offers a premium on neglect. R. E. Verse.



Conventional Pipes and Fittings.

CONVENTIONAL METHOD OF DRAWING PIPES AND FITTINGS.

Editor Machinery:

The drawing of plans for a steam heating system is not usually done in strict accordance with the principles of mechanical drawing. To do so would be a mere waste of time as conventional methods of representing the various pipes and fittings are just as intelligible to the steam fitter as a correct representation would be.

Before commencing the drawing the draftsman should measure the building carefully. It is not safe to rely entirely on the architect's plans of the building, as frequently a wall is made a little thicker or thinner than the plan calls for. In a case like this the waste of time in recutting and threading pipe may amount to as much as the expected profit. Another point to be considered is the height of the various floors; these are frequently different, sometimes on the same floor there is a difference of a few inches in the height. Upper floors have usually more area than the lower floors, due to the thickness of the walls decreasing toward the top. If this is not taken into account a riser that is about 4 inches away from the wall at the first floor may be 12 inches away at the top floor.

The simplest conventional way to represent a piping system is shown in Fig. 1. The pipe is represented by straight lines *p*, the fittings by crossing the former with short lines and by circles or parts of circles.

When it is desired to have the drawing represent a pipe a little better than done in Fig. 1 we may use two lines. In this way the various fittings will, of course, look better, but in the writer's judgment, all this extra labor is in most cases merely time wasted. In Fig. 2 is shown an arrangement of piping in which the pipe is represented by double lines.

Frequently there are three lines of piping, one under the other, or alongside. In the drawing they are shown side by side. These pipes are usually steam, return, and drip. To prevent misunderstanding they may be drawn in different colored inks; say black for steam, red for return, and blue for drip. For blue-printing the use of colors is not recommended, therefore black alone should be used; the steam pipe may be represented by solid lines, the return by dots, and the drip by dashes, as shown in Fig. 3. In every case, however, an index should be given on the drawing.

A very important point is to see that the size of each length of pipe is distinctly marked.

When a drawing is to be made for "show" the piping may be shaded something like Fig. 4.

Fig. 5 shows conventional ways of representing various coils.

Fig. 6 shows a plan of a radiator; it is merely a small rectangle. The number of square feet of heating surface it is to have should be stated; the symbol given after the 50 (in Fig. 6) stands for "square feet," it is simply a small square with an *f* drawn over it.

Fig. 7 represents an elevation of a radiator, it consists of a number of vertical lines joined, freehand, at bottom and top so as to represent the various sections. An air valve is shown at *a* and a radiator valve at *b*.

Fig. 8 shows a conventional way of showing a register, Fig. 9 a pin radiator. Figs. 10 and 11 show ways of representing air ducts. Where a riser is to be shown leading up to a register it is merely necessary to make a small rectangle as shown.

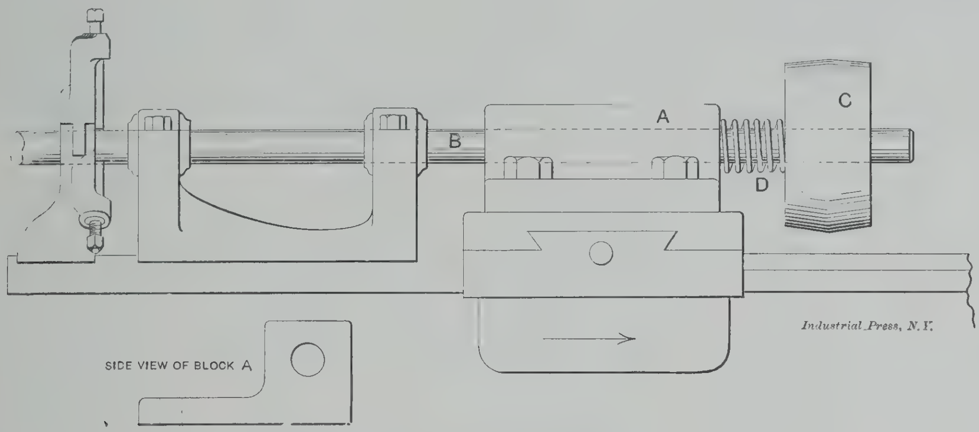
Many other conventional methods could be shown but the ones illustrated above are perhaps the best, as they are quite simple. CHARLES G. PEKER.

New York, N. Y.

RE-BORING HEADSTOCK BOXES.

Editor MACHINERY:

In the September MACHINERY, "Connecticut" asks for a method of re-boring headstock boxes. I send the accompanying sketch to show a very simple way in which this may be done.



Arrangement for Re-boring Headstock Boxes.

Before dismantling the lathe, the block *A* is bolted to the tool post and bored out to carry the boring bar *B*. The cross slide gib screws should be set tight to prevent the block from getting out of line after it is bored. The headstock is then dismantled and set forward on the ways sufficiently to allow the steady rest to be placed on the end of the bed as shown. The boring bar is centered in the steady rest and is fed by moving the carriage in the direction indicated. It is driven by the pulley *C* and the spring *D* is provided to keep the bar from jumping in feeding. C. P.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published

3. C. Payton.—Will you please inform me whether or not there is a standard for threading steam and gas pipes which gives the number of perfect threads each respective size should have?

A.—We reproduce the following extract from a table of standard wrought iron pipe sizes, published by Morris, Tasker & Co., Philadelphia, and which may also be found in Kent's Mechanical Engineers' Pocket-book.

Nominal size of pipe.	No. of threads per inch.	Length of perfect thread.
⅛	27	.19
¼	18	.29
⅜	18	.30
½	14	.39
¾	14	.40
1	11½	.51
1¼	11½	.54
1½	11½	.55
2	11½	.58
2½	8	.89
3	8	.95
3½	8	1.00
4	8	1.05
4½	8	1.10
5	8	1.16
6	8	1.26

The taper of the thread is ¾ inch per foot for all sizes.

4. W. J. D. I have a plate bearing a series of knives which are about 7-64 inch thick, and from 9-16 to 11-16 inch wide on the end. Both plate and knives are malleable iron. I wish to harden these knives in the shortest time and cheapest way, the case-hardening to extend back about ⅜ inch from the end, the balance of bar and knives to remain soft and the points not to be brittle. Will you advise me as to the best way to do this?

A.—Melt some cyanide of potassium in a crucible or an iron dish. A comparatively shallow dish would answer the purpose. It must, of course, be large enough to receive all the projections. The cyanide must be heated to a red heat. The blades may be immersed in it and left for a sufficient length of time for the cyanide to penetrate to the desired depth. (This must be a matter of experiment, with a scrap of the same metal.) When heating in the cyanide the blade should be worked up and down a trifle, to prevent a fire crack. When heated for the proper length of time it may be removed and plunged in a bath of water. Should this, however, make the metal too brittle, use a bath of sperm oil and tallow—equal quantities. If this does not make them hard enough add alum to the oil until the desired result is obtained; although I should say the bath of water would harden them all right; malleable iron is a variable quantity to consider, as no two foundries turn out a product exactly alike, and no one foundry (so far as I know) turns out a product that runs uniformly right along—if considered from a hardener's point of view. It is best to get a good quality of cyanide, being careful *not* to get one made expressly to produce colors. There is a brand made which, when malleable iron gun frames are heated in it and dipped in water, will produce the most beautiful colors, but will not harden the work. But that is a *special* brand, and is not used for ordinary purposes. Cyanide is a violent poison, and care should be taken not to allow any moisture to get into red hot cyanide, as this would cause it to fly and perhaps severely burn the person using it.

5. Subscriber.—"Kindly state through your columns how a double helical gear (herring-bone gear) is cut, especially how the corners where the angle formed by the meeting of the teeth of the two parts of the gear are worked out so sharp and neat."

A.—If the gear is to be in one piece and the teeth must meet at a sharp corner we know of no other way than to work out the corners by hand. As this entails a great amount of work, several methods are employed in order to avoid the hand work. It is very common practice to use two gears side by side, as shown in Fig. 1. One is cut with a right-hand spiral and the other with a left-hand spiral and they are driven from the shaft by the same key. If thought necessary they can be fastened together by bolts or pins running parallel with the shaft. Another method, which permits of the gear being made in a single piece, is shown in Fig. 2. It consists in omitting a small portion of the teeth where the corner comes, which permits the teeth to be milled in the usual way.

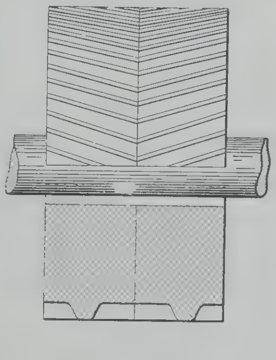


Fig. 1.

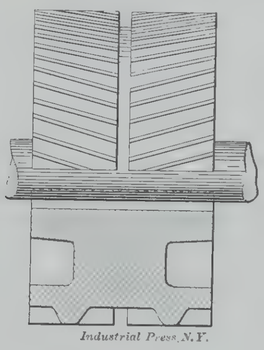


Fig. 2.

ITEMS OF MECHANICAL INTEREST.

GERMAN GLOBE VALVES—TAP SCREWS IN TAIL SHAFT LINERS—EXPANDING PULLEY—WORM GEARING—RECOIL OF GUNS.

The availability of petroleum as fuel depends on its price relative to that of coal. Roughly speaking, four barrels of petroleum are equal in heating capacity to one ton of good coal. It is quite probable that one pound of petroleum cannot be made to evaporate much more than 16 pounds of water from and at 212 degrees F. The evaporative capacity of one pound of good coal under the best conditions may be safely put at 10 pounds of water from and at 212 degrees F. So the practical calorific value of good bituminous coal may be said to be about five-eighths that of petroleum, pound for pound. A barrel of petroleum weighs, say, 330 pounds, or six barrels to the ton. At $1 per barrel petroleum is no cheaper than coal at $3.75 a ton.

The following note is taken from a recent report of the British Admiralty Committee on Naval Machinery:

Submitted, that for lining bearings, crankpins, bushes and other parts, exclusive of crosshead bushes, the following alloy has, in hard ocean steaming, been found, after extended experience, to give good results: 12 parts tin, 1 part copper, 1 part antimony, mixed in the following way: Six parts tin alloyed with 1 part of antimony, and 6 parts tin with 1 of copper, and the two mixed together. For lining crosshead brasses the following harder alloy has been found to give good results: 85 per cent tin, 5 per cent copper and 10 per cent antimony.

Clear glass is objectionable for the sunny side of a shop having large windows extending to the eaves, or in skylights. The sunlight pouring through on hot days makes a glare and heat that are unendurable. Ground glass is expensive, but a good substitute for it may be easily made by stippling clear glass with white lead and oil. This can best be done by a brush whose bristles are cut off short and square. The bristles of such a brush are dipped into a shallow dish containing the white lead and oil and then struck end on against the glass. Each bristle leaves a small dot of white on the glass that is permanent when once well dried. In this way the light passing through may be broken up without greatly reducing its total volume.

Where steam pipes are carried underground they should, of course, be covered with some insulating material to reduce the losses from condensation, and also as a measure to prevent rapid deterioration by rusting. The general experience of steam-heating companies in cities seems to indicate that the best covering for underground steam pipes is a casing made of white pine having about a 4-inch shell. The casing is built up of staves which have been thoroughly kiln-dried and coated with asphaltum. The lengths should be joined by mortise and tenon joints well made, so as to exclude all moisture. The loss from condensation with such a covering is said to range from 1½ to 6 per cent per mile of pipe of, say, 6-inch size. The loss is, of course, proportionally smaller for larger pipes when the circulation is the same, and greater in both cases when the circulation falls below normal.

The *American Engineer and Railroad Journal* relates two unusual examples of rapid cutting that were recently made at the Bethlehem Steel Company, with Taylor-White steel tools, which well illustrate the phenomenal qualities of that steel. In one instance a cut 1 3-16 in. deep was taken on a nickel-steel electric power house shaft mounted in a 90-in. lathe and revolving for a cutting speed of 25 feet per minute, the rate of feed being 3-16 in. per revolution. In the other, a nickel-steel crank shaft for a protected cruiser was machined in a 50-in. slotter by a cut 1⅛ in. deep and a feed of 1-16 in. per stroke, the cutting speed being 18 feet per minute. The former case corresponds to a removal of 66.78 cu. in. of metal per minute, or 2.318 cubic feet per hour. The great capacity of such rapid cutting can be better appreciated when it is considered that the rate mentioned corresponds to the removal of 1134.9 lbs. of steel per hour, or of 5.67 tons per day of 10 hours steady cutting.

OIL GROOVES IN SHAFTS.

The persistency of an idea that has been instilled by early training, whether in religion or in trade, is quite remarkable to say the least. No trade or avocation is without its traditions and precedents, and it sometimes requires considerable courage to oppose them even if a variant practice is obviously better. One of the most persistent ideas in the machine business is that oil grooves for lubricating bearings should be cut on the inside of the boxes. Probably not one machinist in a hundred ever thinks of cutting them in the shaft, and it is hard to convince the average machinist that such is the best practice. Once in a while some writer in a technical journal will point out that the old practice is inferior to cutting the grooves in the shaft, but it makes little impression and the average machinist goes on in the same old way. It is somewhat refreshing to find a machine tool building concern that follows the shaft-grooving practice for distributing the lubricant and to know that they have been doing it for some years. The Binsse Machine Co. groove all shaft bearings with spiral grooves, usually two in reverse spirals. This is done on short shafts by the milling machine, and the results are eminently satisfactory. There may be other manufacturers following the same practice, but they are not so common as they should be. Let the shaft be its own oil distributor; gravity is too uncertain.

GLOBE VALVES WITH LEVER AND SCALE.

A frequent cause of boiler explosions is the too sudden opening of the throttle, especially where the machine to be served is a "steam-chewer" like a steam hammer.

To prevent this and other annoyances of greater or less magnitude and to enable one to see just how far the valve is open, the globe valves shown in Figs. 1 and 2 have been brought out by a German manufacturer, Dreyer, Rosenkranz & Droop, of Hanover.

This design has also the advantage of rendering the opening and closing of large valves more easy.

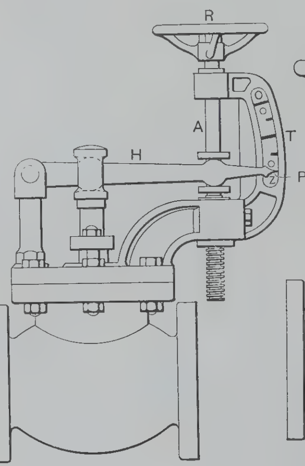
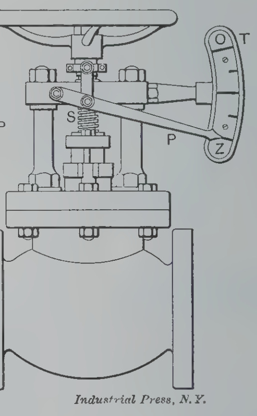


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

As will be seen in Fig. 1, the stem is not threaded but is a straight, plain rod playing up and down in the stuffing-box.

The work of opening and closing the valve is performed by the screw *A* and its handwheel *R*. Any desired degree of leverage may be gained by proportioning the arms of the lever *H*, and the degree of rapidity of opening and closing is regulated by the pitch of the thread on the spindle *A*.

The position of the double pointer *P* as regards the double-faced scale *T* shows the degree of opening attained.

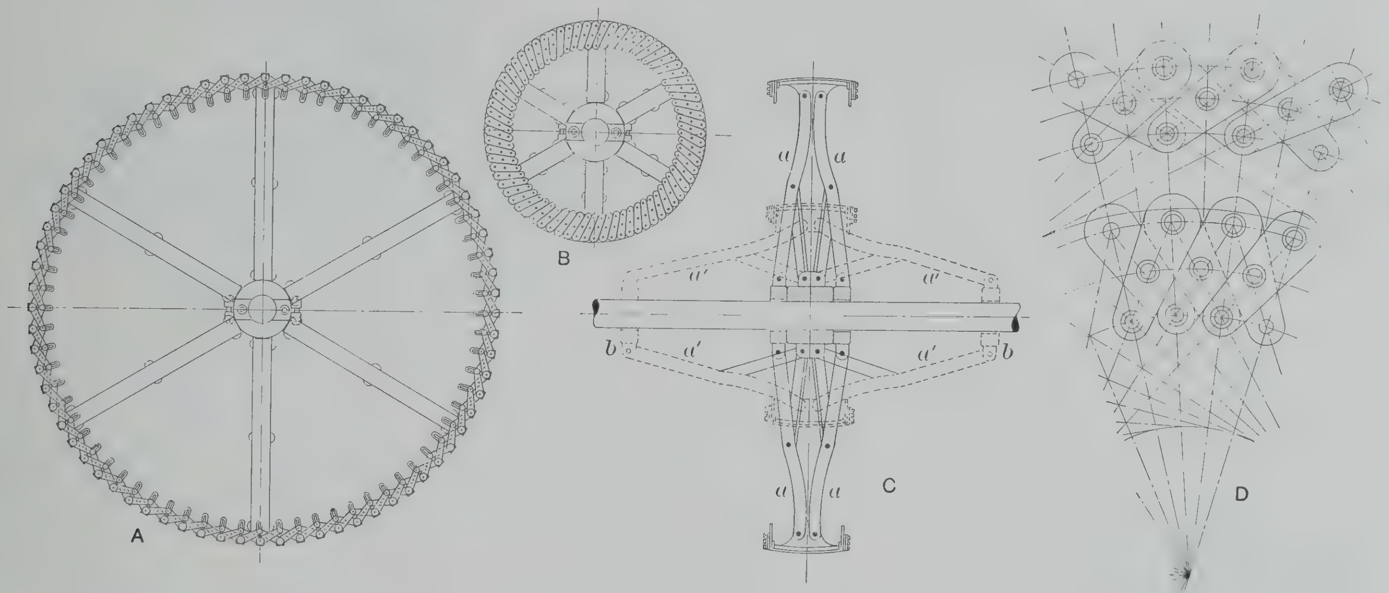
Fig. 2 shows a valve having double pointer *P* and double-faced scale *T* without the lever.

THE USELESSNESS OF TAP SCREWS IN TAIL SHAFT LINERS.

In an article, "Tail Shafting for Marine Engines," which recently appeared in *Marine Engineering*, the writer, Mr. J. P. Badenhausen, quite properly condemns the common practice of putting screws through tail shaft liners to hold them to the shafts. He says tail shaft liners must be made of specially good composition, since the stress set up by shrinking them in place has sometimes been sufficient with common alloy to split a liner from end to end. Notwithstanding the fact that the liners are shrunk in place, some marine engine builders make it a point to additionally secure such liners by countersunk tap screws. In his opinion this practice is not only unnecessary but is often the cause of great injury to the shaft. If the liner becomes loose so that the screws are the sole dependence for holding the shaft and liner together, great harm may be done, since the liner is loose and salt water will get between it and the shaft and cause corrosion. The liner being held in place by the screws it becomes doubly dangerous, as the corrosion may proceed indefinitely before it is detected. If a liner gets loose the sooner it is known and remedied the better. Again, the holes drilled into a shaft for the screws tend to weaken the shaft and form the starting point of cracks that otherwise would not have been developed.

EXPANDING PULLEY.

The illustrations, *A*, *B*, *C* and *D*, show the principle of a novel expanding pulley made by Delagneaux, of Paris, for varying the speed of automobiles. *A* shows the pulley expanded to its largest diameter, and *B* contracted to its smallest diameter. The ratio of the largest diameter to the smallest diameter is 2⅛ to 1. So if the two pulleys like *A* and *B* were belted together, the variation of speed possible would be about 4.5 to 1. *C* shows how the arms are jointed so as to collapse to the smaller diameters. When the arms are in the position indicated by *a a a a* the pulley is expanded to its largest size; when they are in the position indicated by *a′ a′ a′ a′* it is contracted to the smallest diameter. The principal novelty of construction, however, is the structure of the rim. It is made up of short sections mounted on short levers, which are jointed together in pantagraph form. The upper part of illustration *D* shows the position these levers take when the pulley is expanded; and the lower portion when it is contracted. The same action is also illustrated in the views of the two pulleys *A* and *B*. The obvious advantage of this somewhat complicated structure is that the pulley is always approximately circular in form no matter in what position it is. This produces a smoother action than is possible with the type of expanding pulley having the rim divided into a small number of sections.



Industrial Press, N.Y.

An Expanding Pulley.

WORM GEARING OF HIGH EFFICIENCY.

The *Electrical Review*, in a recent article, gave a short account of some experiments with worm gear transmission which were made by Messrs. Rosling & Fynn, Limited, of Bradford, Yorkshire, England. Starting with an efficiency of 67 per cent, which was considered good only a few years ago, by careful selection of material, design of pitch and thread, and good workmanship, they have been able to produce a worm gear with a reduction of 40:1, having a guaranteed efficiency of 90 per cent, in the case of a 4 H. P. set and 91 per cent in the case of a 10 H. P. set. In both of the above cases the worm wheel ran at a speed of 40 revolutions per minute. The worm wheel is of a special mixture of phosphor bronze and the worm is of tool steel, both accurately ground and polished; they run in an oil bath of ample size, the end thrust being taken up by ball bearings. Messrs. Rosling & Fynn, Limited, have had some of these sets running for over two years, working steadily 8 to 10 hours a day, and so far there are no appreciable signs of wear.

These sets are used to give the required reduction in electrical driving.

RECOIL OF LARGE GUNS.

It is a well-known principle of mechanics that action and reaction are equal and in opposite directions. The momentum of the gun and the shot fired are equal. The boy who has just fired a musket for the first time realizes the truth of the principle although he may not greatly admire it. When the musket becomes a rifled gun weighing 50 to 60 tons, firing a shot weighing a ton or more, the same principle still applies. J. F. Meigs in an article "Ordnance Engineering" in the *Engineering Magazine* illustrates the immensity of some of the forces called into play on a great battleship by a statement of the quick recoil of big guns. He says that one of these guns weighing as much as a fair-sized locomotive, is projected to the rear at a rate of 25 feet per second when fired. The hydraulic recoil plunger brakes stop it in a distance of about 36 inches and powerful springs instantly return it to the firing position. So quick is the movement that the eye usually fails to note it, and devices are used in gun turrets to prevent guns being loaded twice on account of the inability of gunners when in action to tell whether a gun has been fired or not. Nothing, perhaps, gives an idea of the great forces in action so well as the snapping of a 50-ton weight to the rear and back again so quickly that the human eye can scarcely see it.

* * *

The New York *Sun* publishes some interesting figures regarding the capacity of the two mammoth steamships now building at New London, Conn., for the Great Northern Steamship Co. When completed these vessels will ply between Seattle and the Orient and will have a larger capacity than any vessels in the world.

Each vessel has deck room of over five acres, available for carrying freight and can carry over 900,000 bushels of wheat. Taking the average 36-foot car, with a capacity of 60,000 pounds, this would make a railroad train nearly seven miles long. To transport a full mixed cargo of one of these vessels would require 2,500 ordinary railway freight and passenger cars. The vessels will each be 630 feet long, 73½ feet extreme beam, 55 feet 6 inches in depth; have a gross tonnage of about 21,000 and an extreme load displacement of about 38,000 tons.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

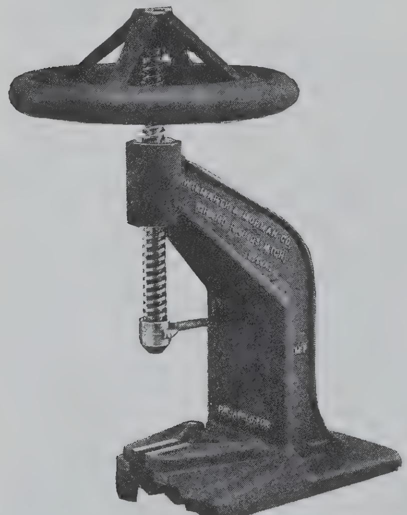
The L. S. Starrett Co., Athol, Mass., have recently brought out a test indicator which can be attached to the needle of a surface gage or to any flat or round support up to ⅜ inch in diameter. With the indicator is furnished a holder to go in the tool post of the lathe. The head of the needle has three working points so that the indicator may be used on work in front, above or below it. The gage is graduated to read in thousandths of an inch.

The Whitman & Barnes Mfg. Co., Akron, Ohio, have brought out a wrench which is a combination of a nut and pipe wrench. In general appearance it is similar to an ordinary machinists' wrench except that it has two sets of jaws, one set having the usual flat faces for use on nuts and bolts while the other set is grooved for gripping steam or gas pipes. The lower jaw on the pipe side is mounted on a pivot which enables it to engage or release the pipe in the same manner as an ordinary pipe wrench.

Nutter, Barnes & Co., Boston, Mass., have just placed on the market a new metal cutting off machine and an automatic grinder for sharpening the saws which are used. The machine uses a 13-inch saw ⅛ inch thick, and is capable of cutting iron or steel of any shape up to 4 inches in diameter. The saw and the gear mechanism by which it is driven, are mounted on a slide which has a forward feed, variable from ¼ inch to 1 inch per minute, and a quick return motion. The saw grinder automatically sharpens the 13-inch saws in about six minutes. The teeth are spaced by an accurately cut index having the same number of teeth as the saw.

"YANKEE" ARBOR PRESS.

The screw press shown in the cut is designed for forcing arbors, straightening work, or any of the purposes for which an arbor press is used. It is built by the Wilmarth & Morman Co., Grand Rapids, Mich. The screw has a coarse pitch, is double threaded, and has a handwheel with heavy rim, the inertia of which is utilized to force the arbor tightly into the bore of the work. By the use of this combination as great a driving effect is produced as with a sledge, but without the results so injurious to the ends and centers of the arbors. The inertia of the handwheel is made use of for giving the arbor two or three final impulses after it has been forced down as far as can easily be done by turning the handwheel in the usual manner, the leverage being 47 to 1. The thread is of so coarse a pitch that the screw will never lock on the work, but when turned down quickly on a tight fitting arbor, it will be repelled and turn in the opposite direction. The arrangement of the jaws on the anvil to accommodate different diameters of arbors is very convenient; they open and close in unison so that the work is always central under the screw, and arbors can be readily forced in and out of thin bushings. To straighten shafts, etc., the jaws are opened some distance and the pressure applied centrally between. With one hand on the work and the other on the wheel, the ram may be brought down with an easily gaged force and the work quickly straightened without leaving a mark on it. Hardwood strips are inserted in the bottom, so that when bolted to a lathe bed no damage will be done to the ways, while lugs keep the press forward to prevent arbors from marring the front edge.



Screw Arbor Press.

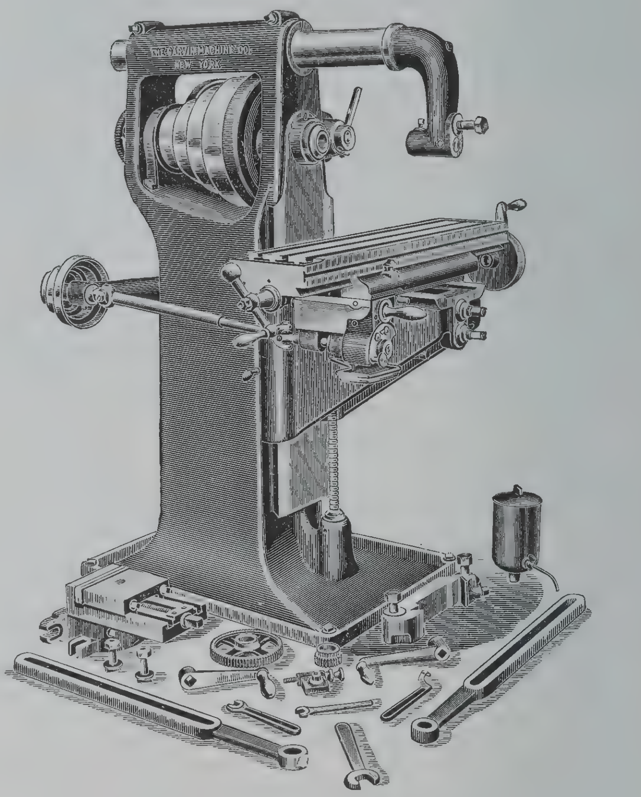


Fig. 1. No. 13 1-2 Garvin Plain Milling Machine.

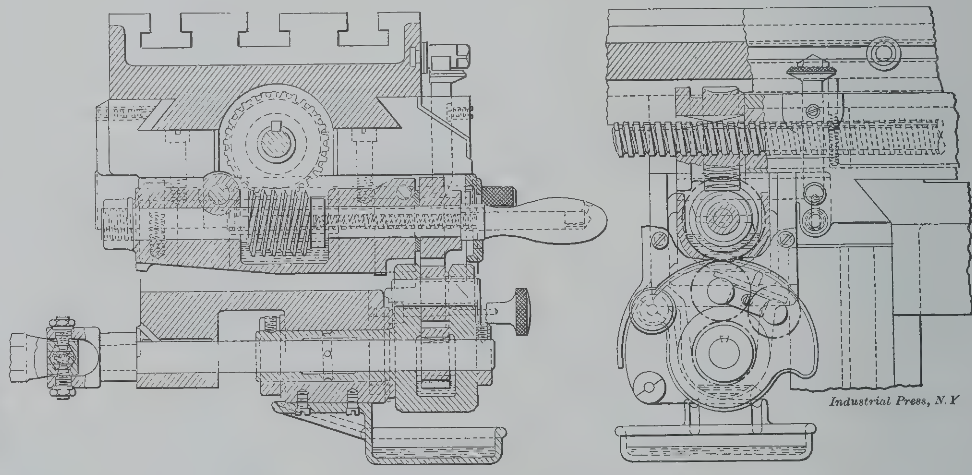


Fig. 2. Section through Feed Mechanism of Garvin Milling Machine.

GARVIN MILLING MACHINE NO. 13½.

Fig. 1 shows one of a new line of plain milling machines made by the Garvin Machine Co., New York, and embodying several recent improvements. The machine is back geared, which enables it to carry heavier cuts and at a faster rate than the usual plain miller and also provides double the number of feed changes. The table is provided with three T-slots and has a quick return, consisting of an internal gear and pinion, that is placed at the end of the slide and is entirely enclosed on all sides. The knee is of the box construction and has extra long in-and-out adjustment. The feed mechanism is shown in Fig. 2. The most direct system of gear ing is employed with a minimum number of separate parts so arranged as to respond instantly to the trip under the most severe strain when going in either direction. The drop block, carrying the worm shaft, is in one piece pivoted on a line with the top of the worm. As will be seen in the diagram, this block forms a pocket in which the worm runs in oil both when working and when tripped. The reverse motion is combined in the box and operated by a small knob at the front where most convenient.

The reversing mechanism is of the usual rocker, three-gear type. The rocker is locked in position by a plunger operated by the knob seen in front of the rocker casting and can be thrown over instantly while the machine is running. The trip and latch parts are of the plunger type. The trip button on the side pushes down the vertical plug and this acts by means of an inclined notch to withdraw the horizontal plunger from under the pin, on the side of the drop block, and allows it to fall. A noticeable feature of this machine is the universal joint. This has adjustment for taking up all wear and a center hole in the block, filled with felt, serves as an oil reservoir for the pins.

A NEW DRILL COLLET.

Figs. 1 and 2 illustrate a new tool recently patented by A. S. Davis and assigned to the Seneca Falls Mfg. Co., Seneca Falls, N. Y. This tool, which is designed for use in the spindle of upright drills can also be used in lathes and other horizontal spindle machines, for the easy and rapid change of drills, reamers, counterbores, taps, etc., without stopping the machine.

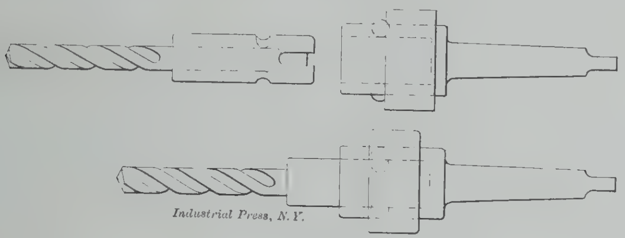


Fig. 1. Chuck, Drill and Collet.

The chuck consists of a socket piece with two steel balls, also a locking ring mounted loosely on the body of the chuck, which may be held in the hand while the chuck is revolving.

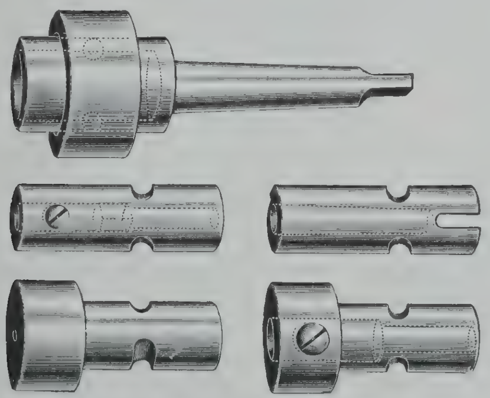


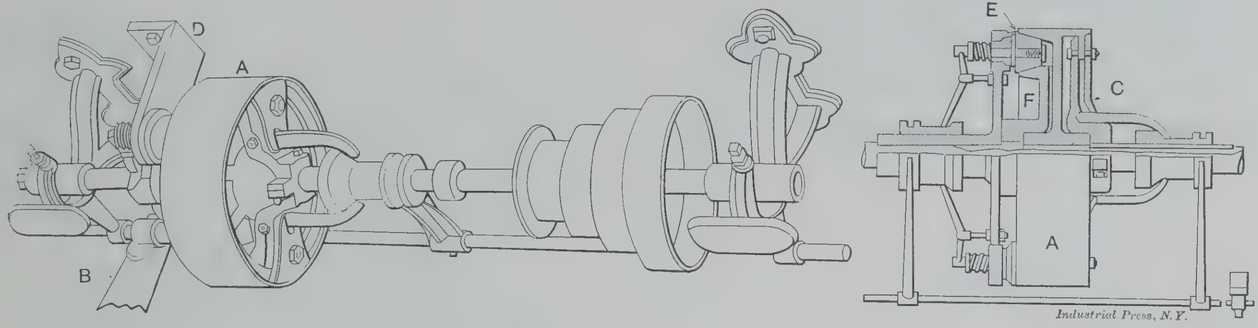
Fig. 2. Chuck and Collets.

The collets are provided with two segmental grooves for receiving the balls which perform the double duty of holding the collets in place and driving same.

To change the collets, it is only necessary to raise the locking ring which instantly releases the balls, allowing the collet to drop out, when another can be inserted, and by dropping (or releasing), the locking ring, the balls roll into place, instantly locking the collet.

It is claimed that owing to the peculiar construction of this chuck, collets can be conveniently and safely changed when machine is running at the highest speed, as there is nothing to catch or shock the operator.

Fig. 1 shows the chuck, collet and drill, both before collet is inserted in chuck and with the collet in place. Fig. 2 shows the chuck and various styles of collets that may be used.



Friction Reversing Countershaft.

A FRICTION REVERSING COUNTERSHAFT.

The cut illustrates a new countershaft reversing mechanism that has been brought out by Upton & Gilman, Lowell, Mass., for use with lathes and machines of a similar character.

The noticeable feature of this countershaft is, that it is driven by a single belt but may be reversed by the same motion of the shifter that is employed for reversing the ordinary countershaft with open and crossed belts. The use of such a countershaft reduces the amount of driving belt required and also the overhead room occupied. The method by which the reversal is accomplished will be clearly seen by reference to the cut.

The pulley *A* runs loosely on the shaft but by throwing the shifter *B* to one side the friction clutch *C* engages the pulley causing it to drive the shaft in the same direction in which the pulley is revolving. On the opposite side of the pulley is the auxiliary hanger *D*, carrying two or more conical rolls *E*. When the shifter is moved in the reversing direction, these cones are forced between the beveled disk *F* and the bevel on the under side of the rim of the pulley *A*. The introduction of the cones causes the pulley to drive the disk *F* and consequently the shaft, to which it is keyed, in a direction opposite to that in which the pulley is revolving.

Owing to the difference in diameters of the bevel on the pulley and the disk the usual increase of speed is obtained that is desired for quick return.

UNIVERSAL BOX TOOLS.

The accompanying cuts show a universal box tool which has been brought out by the Bayldon Machine & Tool Co., Jersey City, N. J.

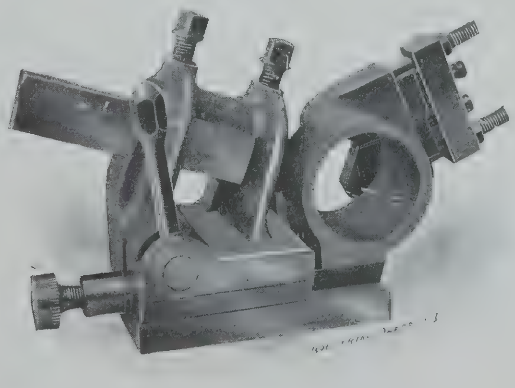


Fig. 1. Universal Box Tool. Back View.

It was originally designed to go with the interchangeable tool posts manufactured by this company, but it is also universal in that it may be used in any turret or bolted directly to the lathe carriage. The steady rest is in two pieces and adjustment is provided by means of backing-up screws. The tool is held in a gibbed slide by two set screws and an up and down adjustment is obtained by withdrawing the slide from, or pushing it toward, the work. A micrometer screw adjusts the tool to cut to size, and a cam, operated by a lever, draws the tool back from the work when the cut is finished.

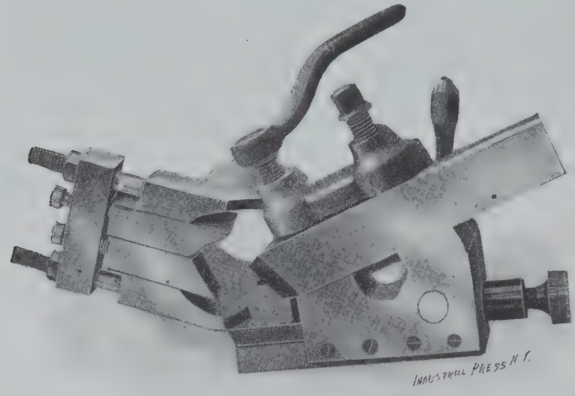


Fig. 2. Universal Box Tool. Front View.

These tools operate stock up to 2 inches in diameter, and use ordinary lathe tools 1 inch x ½ inch.

EMMERT'S UNIVERSAL VISE.

The Emmert Manufacturing Co., Waynesboro, Pa., have just placed on the market a new universal vise for use of toolmakers, jewelers and metal workers. This vise is universal in that it can be placed in every conceivable position. As will be seen in Fig. 1, there are three sets of jaws, any one of which can be swung into any position desired for holding work. One set of jaws is made rough for heavy work, another set is smooth for finished work, while the third set is provided with round projections, upon which may be fitted jaws for taper work, round work, copper work, jaws for holding any size of ring, or pipe jaws. All of these styles of jaws are furnished with the vise. Fig. 2 shows the vise with the jaws for holding taper work, in use.

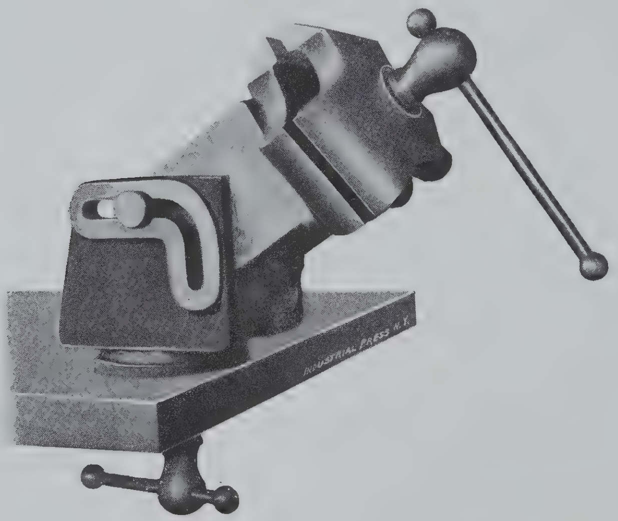


Fig. 1. Universal Vise set at Angle.

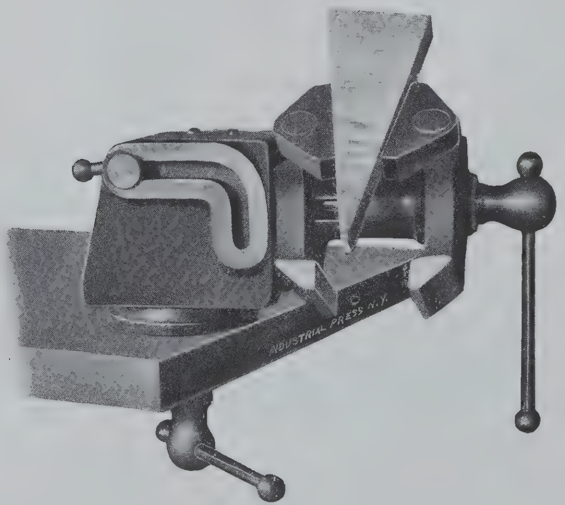
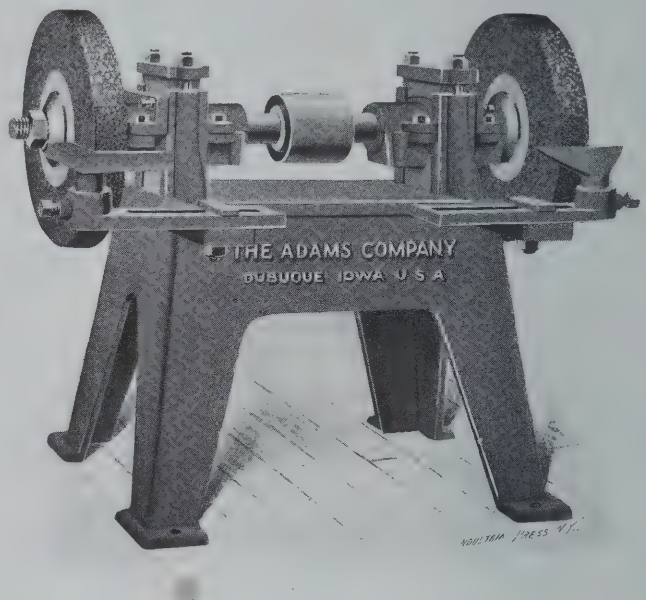


Fig. 2. Universal Vise holding Tapered Work.

NEW HEAVY GRINDER.

The Adams Co., Dubuque, Iowa, have brought out two new grinding machines, one of which is shown in the engraving. These machines are designated as their No. 1, carrying two wheels 12 inches in diameter, and No. 4, the one illustrated, which carries two wheels up to 24 inches in diameter.

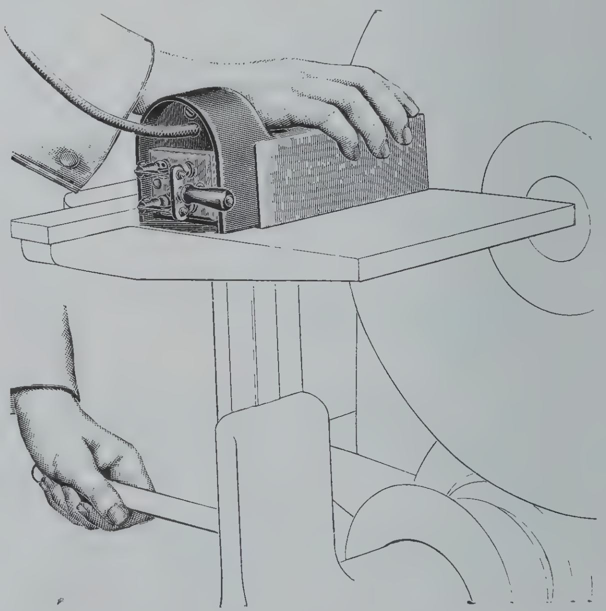


Twenty-four inch Grinder built by Adams Co.

These machines are built for heavy grinding and are provided with long self-oiling bearings which are rendered more serviceable by having the boxes held in position by elastic rubber cushions. The cushioning effect relieves the bearings from the destructive pounding which results from wheels that are running out of true.

MAGNETIC HAND CHUCK.

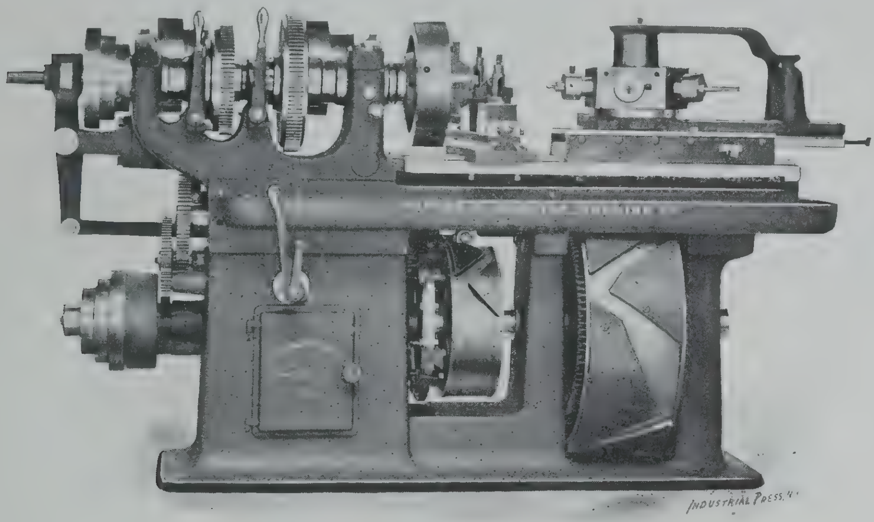
O. S. Walker & Co., Worcester, Mass., have just brought out the magnetic hand chuck illustrated in the accompanying cut. This chuck is designed for holding pieces of work that are being ground on a disk grinder. It is held by hand as shown in the cut, and is aligned by the squaring bar of the regular swinging rest characteristic of the grinders referred to. The electric connections are made by attaching the chuck to any convenient lamp socket of a 110-volt, direct current circuit.



Magnetic Chuck holding Work for Grinding.

MANUFACTURING AUTOMATIC CHUCKING MACHINE.

The cut shown herewith represents the latest improved automatic chucking machine which has recently been placed upon the market by the Potter & Johnston Machine Co., Pawtucket, R. I., who were the pioneers in the development of automatic machinery for the production of duplicate parts from castings. The machine is designed and built for the automatic production of all kinds of castings, either cast iron, steel or bronze, up to 10 inches diameter and 6 inches long. It possesses several new features heretofore unknown to this particular class of machinery. The turret has five sides, with 2½ inch holes, and it withdraws, revolves and advances at forty times the feeding speed. The feed is driven and controlled by the spindle. The cross slide can be operated automatically at any time in conjunction with the turret. The turret slide is operated by a large cam drum driven by spur gearing, the power being applied near the periphery of the drum. This arrangement is very substantial and prevents any springing of the working parts. The tool blocks on the cross slide have a travel of 4½ inches in each direction, and have screw adjustment. The standard set of cams furnished with the machine covers all ordinary pieces up to 6 inches in length and requires no adjustment. The automatic back facing attachment shown in cut is a very valuable addition to the machine. This attachment enables the hubs of gears, pulleys, etc., to be finished on both ends at one setting, and in this manner a large variety of pieces which would ordinarily require to be done in two holdings, can be finished complete at one. Another very interesting feature in connection with the machine is the automatic chuck. By the use of this chuck pieces which can be handled with one hand can be placed into the chuck and removed without stopping the spindle. Thus the machine is running all the time and requires very little attention from the operator, hence he can readily run from four to eight machines, according to the class of work being done, making the labor cost of production a very small item in comparison with the increased output thereby obtained. For gripping extra heavy or eccentrically-shaped pieces, a heavy scroll chuck is furnished. A pair of universal turning and facing tools is provided as part of the standard outfit of the machine, and takes care of all ordinary pieces up to 10 inches diameter. The machine is made in three types, viz., machine with geared automatic change speed head, which is the one shown; machine with belt driven change speed head, and machine with plain head. With geared automatic change speed head, the spindle is driven by two trains of gears, each train having four changes of speed; with the belt driven automatic change speed head, the spindle has four changes of speed; with the plain head machine the speed of the spindle is constant, but has four grade cone. The machine is of liberal dimensions, has plenty of power, strength and rigidity; and all working parts are simple and easy of access.



Automatic Chucking Machine.

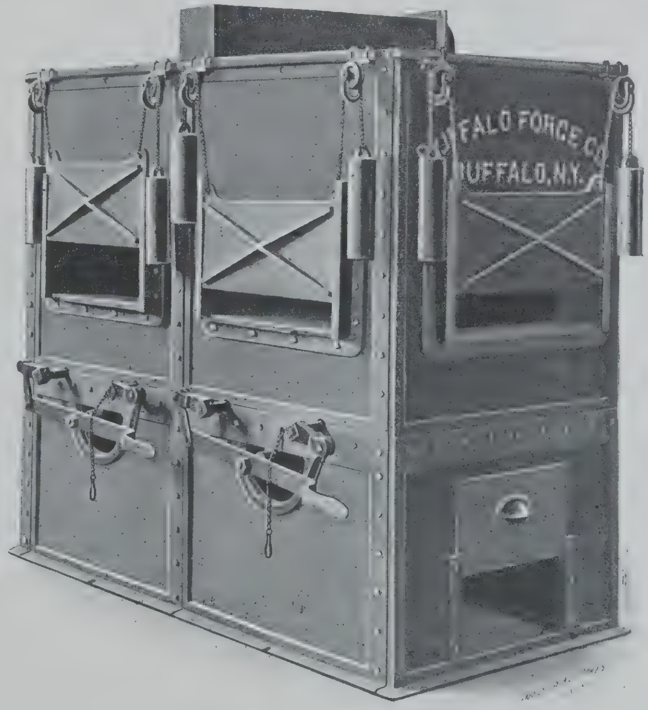
While, of course, automatic chucking machines show up their true value to better advantage when run in groups of, say, half-a-dozen or more, yet if a concern had not a sufficient amount of work to keep several of these going, this machine requires so little attention, that it can easily be run in connection with some other machine, say an engine lathe or a turret machine, and the additional product obtained upon the automatic chucking machine is secured without extra labor cost.

Although this new designed tool has been on the market but a comparatively short time, yet it has been favorably received by the trade, who fully realize the advantages to be gained by the use of such machines. They have already found their way into a number of shops, including the following lines: Textile machinery, printing presses, cream separators, woodworking machinery, pumping machinery, power transmission machinery, electrical machinery, sewing machines, punches, presses, pneumatic hammers, air brakes, etc.

A DOWN-DRAFT FORGE FURNACE.

The accompanying half-tone illustrates a forge furnace recently brought out by the Buffalo Forge Co., Buffalo, N. Y. It is especially adapted for heating work in connection with a steam hammer or similar heavy forging.

A new idea has been introduced in building this forge in sections. Two of these sections are shown in the engraving. In this way the capacity may very easily be increased at any time by installing additional sections. The first or original section is 30 inches long, and each additional section adds 36 inches to the length of the forge, making 66 inches the usual length. Each section is furnished with balanced slide doors on all four sides. When these doors are opened, access may be had to any part of the forge without the least trouble.



Buffalo Down-draft Forge Furnace.

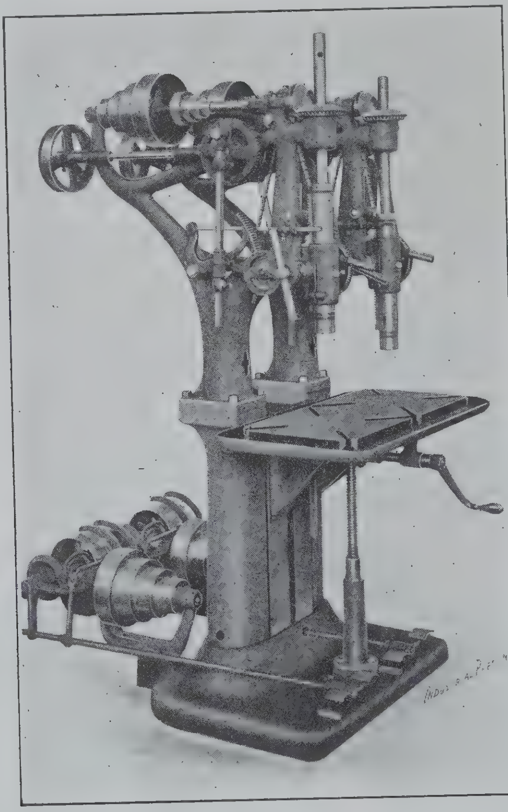
The height from the floor to the top of the grate is 36 inches—the door sills in turn being set slightly above the grate, which is of the improved rocker-grate type 24x66 inches. The cut shows the lever attachment for rocking the grate and removing the ashes, and also the chain which is connected to the air box.

The Buffalo down-draft principle of smoke removal is incorporated in this forge. In the illustration, the stationary exhaust hood is shown at the top of the forge. It carries away all smoke and exhaust gases, allowing none to escape into the shop. The smoke and gases are immediately and completely withdrawn by down-draft suction through underground tile pipe, there being no escape from even the heaviest fires. This does away with all overhead galvanized iron piping, which is subject to frequent renewal, and always obstructs valuable light and space.

A clean-out door is placed at the bottom of each section, allowing of easy access below the grates. The forge is completely lined with fire-brick, and in the roof there is an additional strip of asbestos. The weight of the forge alone, i.e., the two sections without the brick lining is 5,000 pounds.

NEW MULTIPLE SPINDLE DRILL.

The B. F. Barnes Co., Rockford, Ill., have just placed on the market a new multiple spindle drill which is furnished with two, three, or four spindles as may be desired. It is particularly adapted for rapid work in manufacturing plants where there are duplicate pieces to be drilled. The characteristic feature of this drill is that it requires but one performance of the operator for each complete operation of a spindle; that is, when started the spindles go down to the work, drill through and return automatically. All of the spindles run independently, so that one man can easily operate a four-spindle drill.

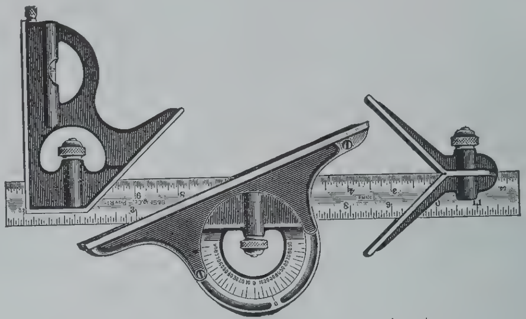


Multiple Spindle Drill.

This machine will drill to the center of a 19-inch circle. The table has a vertical travel of 14 inches and the spindles a vertical travel of 12 inches. It also has quarter-turn countershafts, and many other special features, as will be seen from the photograph.

A NEW COMBINATION SET.

The Brown & Sharpe Mfg. Co., Providence, R. I., have recently placed on the market the new combination set illustrated in the accompanying cut. This set embodies all the essential features of their combination squares with the addition of the protractor head. As all parts are interchangeable, the head can be used on the same blade as is furnished for the combination squares. The revolving turret is engine divided accurately to 90 degrees either side of the zero line and every care is taken to insure this line being at right angles to the face of the head; this, of course, is very essential to the accuracy of the tool. An important feature that has been added is the indication of a second zero line opposite the one shown at the top of the head. This greatly enhances the utility of the tool, making it more convenient for use in setting work and laying out angles, as many times the zero on the upper part of the head will be hidden by the blade and the other zero can, in such cases, be used to read from.



Combination Square, Level and Protractor.

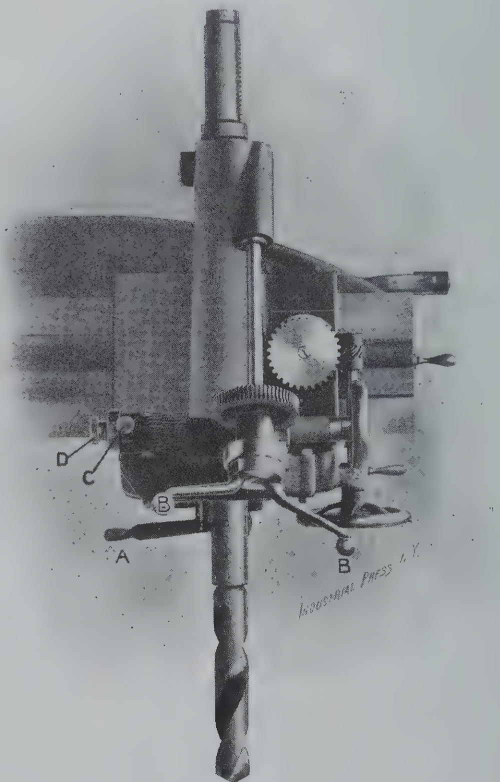
The clamping groove of the blade, instead of being square and having sharp corners, as is usual in tools of this kind, is round. This, beside allowing the rules to be made stronger, also insures the blade being drawn up against the side of the head square with the face when clamping. This form of groove also prevents the accumulation of dirt, as there are no sharp corners, a feature much appreciated in tools of this character.

Each head is furnished with a level, which forms an important adjunct to the protractor head, allowing same to be used as an inclinometer. The level is accurately set for parallelism and after the adjustment is made it is rigidly clamped into position.

Another feature that has been added to these protractors is a reversible head. This allows either side of the tool to be used in transferring angles and avoids, in many instances, the necessity of resetting. The face of the head projects about ½ inch each side of blade, making the face in all about an inch wide. The length of these heads is about 7 inches.

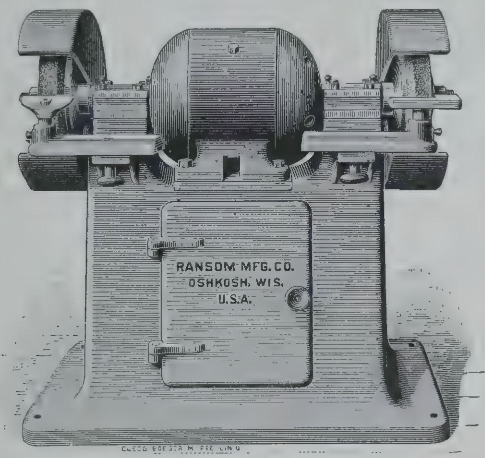
IMPROVED HEAD FOR RADIAL DRILL.

The Wm. E. Gang Co., Cincinnati, Ohio, builders of the five foot radial drill illustrated in the September number of MACHINERY, have perfected a new head and feeding mechanism which they are applying to this drill.



New Head of Radial Drill made by Wm. E. Gang Co.

The feeding mechanism is so designed as to eliminate the necessity of added weight for counter-balancing the spindle. It will be seen that the lower part of head is formed into a casing which entirely surrounds the driving gears on and near the spindle. Gear covers, not shown in cut, are placed over all other gears. The arm is of the usual oval section, enclosed, with web across the front, and heavily ribbed and braced. Two trains of gears connect spindle with shafts at back of head so that a slight up or down movement of lever *A* gives a slow or fast speed. The spindle gear is placed in the lower part of the head so that power is applied to largest diameter of spindle and close to the work. Ratios of gearing between spindle and shaft at back of arm are 18 and 3¼. All handles are conveniently located and easily and quickly manipulated. The machine is provided with an ample number of spindle speeds and feeds.


RANSOM MFG. CO.
OSHKOSH, WIS.
U.S.A.

Electrically-driven Emery Grinder made by Ransom Mfg. Co.

BB are handles which, when used as cranks, give means of quickly traversing the spindle in either direction. A light pressure up or down on one or both of these handles instantly connects or disconnects the feed by means of a powerful friction. *C* is a knob, by turning which, any one of the feeds is quickly obtained when the drill is working. The knob *D* operates a friction for disconnecting the feed gears so that when not in use, all these gears and shafts are at rest. The lower handwheel is for traversing the head along the arm by means of spiral gears, rack and pinion, while the upper wheel is for feeding the spindle by hand.

Another improvement that has been made on the drill is to so construct the column that it is raised from its seat onto roller bearings when the arm is revolved.

This machine has successfully tapped 6-inch iron pipe flanges with evidence of considerable power to spare.

RANSOM EMERY GRINDER

The Ransom Mfg. Co., Oshkosh, Wis., have brought out an electrically-driven emery grinder designed to carry two wheels up to 18 inches in diameter. The motor is entirely enclosed and the armature is wound upon a sleeve which is keyed directly to the spindle of the machine. The journals are of cast iron and are provided with ring-oiling devices which supply oil on top of the shaft when the grinder is running.

The motive power is furnished by a 5 H. P. motor, which is capable of carrying an overload of 50 per cent. Careful tests show that to run this machine free with two 18 x 2-inch wheels, 1,200 revolutions, on a 220 volt current, requires ¾ H. P. To run it with one man grinding very hard requires 3 H. P., while with two men pressing as hard as possible 6 H. P. is required. As the motor is capable of 50 per cent overload it will be seen that the power of the motor is sufficient for any load that can be put upon it.

ELECTRICALLY-DRIVEN BOILER TUBE CUTTING MACHINE.

The Bignall & Keeler Mfg. Co., Edwardsville, Ill., have recently made a number of machines illustrated in Figs. 1 and 2, which are used in tube mills for cutting boiler tubes. These machines are designed to cut tubes from 2 inches to 5 inches in diameter, and from 8 feet to 20 feet in length. The bed is provided with two movable carriages, each carriage being equipped with a heavy steady rest, cutting off tools, and reaming lever, the steady rests having interchangeable blocks which are babbitted for the several different sizes of tubes; they thus hold the tube firmly around the greater part of its circumference, and provide almost perfect rests.

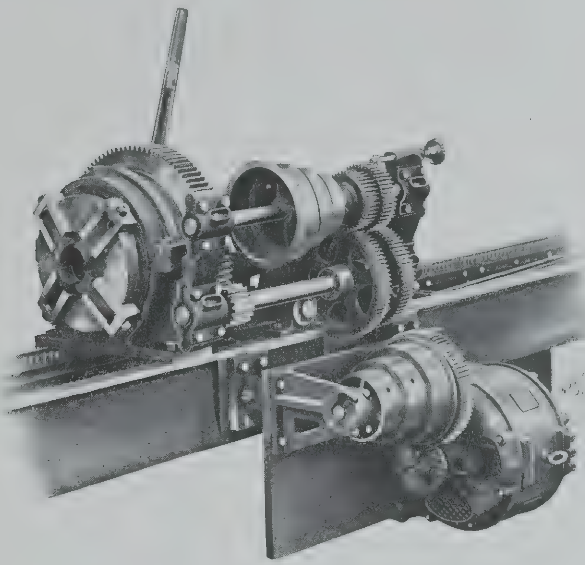


Fig. 1. Electric Drive of Boiler Tube Cutting Machine.

The headstock is built with a lever chuck which is operated while the machine is in motion; in other words, after the grips in the chuck have been set for a certain size of tube, the machine can be run continuously while working on that one size of tube, and as the machine is run for a day or several days on the same size of work the lever chuck accomplishes a great saving in time. A separate set of grips is used for each size of tube. The grips are made of tool steel, tempered, and are turned to the exact outside diameter of the tube. The inside of the grip is left perfectly smooth and they hold the tube by friction only, but as they grip the tube around almost its entire circumference there is no likelihood of its slipping.

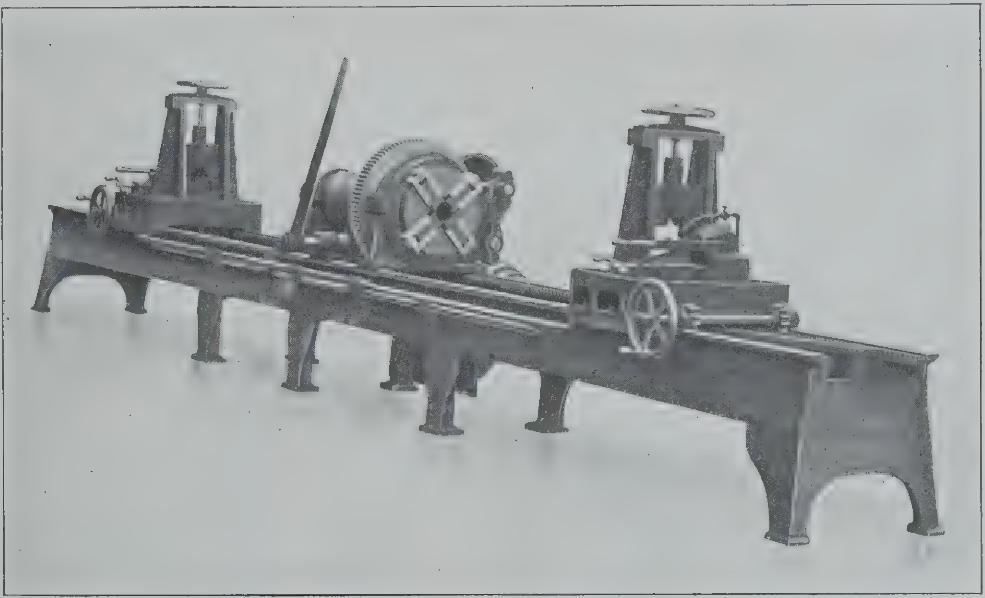


Fig. 2. Double End Boiler Tube Cutting Machine.

The machine is equipped with a 3 H. P. Westinghouse induction motor. The motor, shown in Fig. 2, is held on a swinging table which is hinged to the side of the bed. It is geared into a countershaft supported on this same table. A short belt is run between the countershaft cone and the machine cone. The weight of the motor and the countershaft provides the necessary tension.

The machine is provided with an automatic oiling system, which keeps the cutting-off tools of both carriages continuously supplied with oil.

NUT MACHINE AND ANNEALING BOX.

The Ray Automatic Machine Co., of Cleveland, Ohio, have brought out an automatic nut machine, which is the invention of Mr. A. D. Ray.

The machine provides for punching the nut, piercing the hole, chamfering the corners and tapping the thread. The stock is fed to the machine from a coil upon a reel. The machine is fitted with two tapping spindles working alternately, that is, while a nut is being tapped under one spindle another nut is being punched and carried forward to the other spindle, so that no time is lost. Any style of nut can be made on this machine and by the addition of an extra spindle it will work irregular shapes.

It is capable of producing finished nuts at the rate of 30,000 per day.

This company has also placed on the market a steel annealing box, 18 x 10 x 10 inches, made of 18 gage sheet steel. This box is for use with "Vulcan" annealing putty which is produced by them. With it Mushet or self-hardening steels are easily brought into workable condition without in any way impairing the life of the material. Steel to be annealed is heated to a cherry red; then with the box about half full of the putty, it is placed as near the center as possible and covered with more putty until the box is full. It is then tightly packed down, the cover put on and the steel allowed to remain until it is cold. By this process the most stubborn steels may be readily and thoroughly annealed.

* * *

A number of readers desire to see drawings and descriptions of tool chests fitted for the tools that a tool- or die-maker should have. Photographs would add to the value of such contributions as they would give a better idea of the appearance and finish.

* * *

ADVERTISING LITERATURE.

The Garvin Machine Co., New York. "List No. 26" of new and second-hand machine tools.

The Star Dynamo Works, Jefferson City, Mo. Pamphlet descriptive of the company's direct-current dynamos and motors.

L. S. Heald & Son, 222 M. St., Barre, Mass. Pamphlet entitled "Nothing Succeeds Like Success," calling attention to the American center grinder of their manufacture.

The Tanite Co., Stroudsburg, Pa. Circular of emery wheels. This describes the Tanite emery wheel, its productive capacity, its strength, evenness of wear, and other advantages.

Wyman & Gordon, Worcester, Mass. Circular advertising the company's forgings, and containing a short story of Sir William Siemens. This is the seventh pamphlet with short accounts of the lives of noted engineers published, and we are informed others are to follow.

The Akron Electrical Mfg. Co., Akron, O. Reprint in pamphlet form of an address by F. B. Duncan on the "Electrical Equipment in Modern Machine Shop Practice." Mr. Duncan is now connected with the Akron Co.

The Laidlaw-Dunn-Gordon Co., Cincinnati, O. Catalogue of pumping machinery. A full line of compressors is listed and illustrated and a number of useful tables on air, its weight, the flow of air in pipes, etc., are given.

The Chicago Pneumatic Tool Co., Franklin plant, Franklin, Pa. Standard illustrated catalogue of the air compressors manufactured by this company. These are designed for riveting, drilling, chipping, hoisting, but are also suitable for all other purposes where compressed air is used.

The Jeanesville Iron Works Co., Jeanesville, Pa. "Advance Sheet No. 15," containing much information regarding the Jeanesville pump. Many half-tones and line cuts are used showing the different sizes and styles of pumps, and there are tables giving working data on simple and compound pumps.

The Link-Belt Engineering Co., Philadelphia, Pa. Bulletin No. 1001, of the Renold silent chain gear used with electric motors. This chain and its several parts are fully described and illustrated, and it is shown in connection with motors for driving drill presses, boring machines, punches and a number of other tools.

The American Blower Co., Detroit, Mich. Illustrated sectional catalogue No. 141, of "A B C" pressure and volume blowers. These are shown in a large variety of styles. The "A B C" countershafts are also described and illustrated. Eight pages are devoted to a number of useful tables.

The Cincinnati Shaper Co., Cincinnati, O. Catalogue A, Sept., 1902, of "Cincinnati" shapers. These include 16- to 24-inch crank shapers, single-geared and back-geared; 26- to 30-inch rack shapers, triple-geared; and a number of electrically-driven shapers. The "Cincinnati" traverse shaper is also described, several sizes and styles being illustrated by a number of fine half-tones.

The Pratt & Whitney Co., Hartford, Conn. Pamphlet describing the new profiling machines recently brought out. These are made in two sizes, and are for finishing gun parts, sewing machine parts, etc. They are built with one or two spindles, the one-spindle profiler being made for manufacturers who do not need a machine for both roughing and finishing cuts at a single setting of the work.

The Detrick & Harvey Machine Co., Baltimore, Md. Illustrated catalogue of open-side planers. This is a newly issued catalogue and gives a description and excellent half-tones of the company's 30-, 36-, 42-, 48-, 60-, and 72-inch planers. A number of views of the work that is done on these planers are also given. The company also manufacture drilling machines, bolt threaders, nut tappers, saw setting and filing machines, etc.

The Crocker-Wheeler Co., Ampere, N. J. Pamphlet entitled "A Crocker-Wheeler Trolley Trip." This describes a trip by trolley car over the Flint Division of the Detroit United Railway. The pleasant journey takes in Royal Oak, Rochester, Romeo, Oxford and Flint. The power station in Rochester, which furnishes the power used on this line, is described, together with the Crocker-Wheeler machines used therein, and several interesting illustrations of picturesque spots along the line are given.

The Crane Co., Chicago, Ill. 1902 pocket catalogue of steam goods. This is a very complete catalogue, cloth bound, and containing 464 pages, 12 of which are devoted to a very complete index. Valves, cocks, brass and iron fittings, steam and gas fitters' tools, engineers' and engine builders' supplies, wrought pipe, etc., are listed in this catalogue. The standard goods are first described and illustrated, then come the extra heavy goods; next the hydraulic and lastly, wrought iron and steel pipe—an arrangement which greatly facilitates the search for any particular kind of goods. Some useful tables are also given. It will be sent, upon request, to any one interested.

"An Industrial Problem" is the title of a pamphlet upon cost keeping, gotten up by W. S. Rogers, Keene, N. H. It is designed primarily to call attention to the universal cost system devised by Mr. Rogers, but it contains reproductions of the various cost, material, record and other cards required, with an exposition of the system, and full directions for placing it in operation. The system is to be used in connection with a time clock; and for those who desire to adopt it in its entirety sets of cards, a time clock and accessories needed for a full shop equipment will be furnished by the inventor. In working out the system, the effort has been made to reduce the cost in the office, one clerk being required for a plant of considerable size. Further information will be had by addressing W. S. Rogers, Keene, N. H., and the pamphlet will be sent to those interested for 10 cents.

The Cleveland Automatic Machine Co. (formerly the Cleveland Machine Screw Co.), Cleveland O. Handsomely illustrated catalogue entitled "The Cleveland Automatic." This is devoted to a description and illustration of the line of automatic machinery manufactured by this company. Some forty half-tone cuts are used to show the varieties of machines built, which include automatic turret machines from ¼-inch to 6 inch chuck capacity; automatic plain machines of from ⅜- ⅝- and 1¼-inch capacity; 2-inch and 18-inch automatic chucking machines, and the parts made on these; a two-hole turret machine for the rapid making of parts where only two tools in the turret are required; a tool and surface grinder; 4-inch and 6-inch worm milling machines, with samples of the work done on these machines, etc. Thirty pages are devoted to the description and illustration of the attachments to be used on the company's machines and which they carry in stock. These include magazine attachment, independent cut-off attachment, cross-drilling attachment, etc. Altogether this catalogue will prove of the greatest interest to those requiring this class of machinery.

MANUFACTURERS' NOTES.

The Detroit Graphite Mfg. Co., Detroit, Mich., report that their factory is working to its fullest capacity in taking care of current orders.

The Uniform Steel Co., formerly of Newark, N. J., have recently completed a new factory at Rahway, N. J., for the manufacture of high-grade crucible steel for lathe and planer tools, etc.

The J. F. Towsley Mfg. Co., Evans, Gest and Berlin Sts., Cincinnati, O., manufacturers of wood-working machinery, are building an addition to their shop that will nearly double its capacity.

The Nazel Machine Tool Works, Philadelphia, Pa., have moved into new quarters at 1046 Ridge Ave., and are making a full line of portable drills, portable keyseating machines, centering machines and pasteboard box machines.

The National-Acme Mfg. Co., Cleveland, O., manufacturers of screw machinery, have opened an Eastern office at 510 Arch St., Philadelphia, under the management of Mr. L. M. Waite; also a Western office at 2 and 4 South Canal St., Chicago, with Mr. Geo. D. Grant as manager.

The Hendey Machine Company, Torrington, Conn., manufacturers of lathes, planers and milling machines, are adding a three-story brick building, 63 x 140, to their works. Connected with this is a tower five stories high for water tank, etc., to supply the sprinkler with which their plant is equipped.

Pawling & Harnischfeger, Milwaukee, Wis., who manufacture electric cranes and hoists, state that the demand for their products remains very satisfactory. They have recently received a large number of orders from well-known firms for cranes and hoists of various sizes, ranging from 3 tons to 30 tons.

The Diamond Drill & Machine Co., Furnace St., Birdsboro, Pa., builders of grinding machinery, have almost completely recovered from their recent fire and expect to have their new steel plant and iron foundry in operation within the next two months. They are also building a large blacksmith shop and doubling the capacity of their electric plant.

H. B. Rockhill, who for the past two years has been employed as superintendent for the United Cigarette Machine Co., Ltd., Lynchburg, Va., has purchased a two-story brick building, 50 by 100 feet, in Roanoke, Va., to be equipped as a general first-class machine shop. This will be known as the Rockhill Machine Works, with a capital of $10,000. The works will be in operation December 1st.

The Crocker-Wheeler Co., Ampere, N. J., held at their works in that city on Sept. 25 and 26 their annual managers' convention. A banquet took place on Sept. 25, for the officers of the company. Many interesting speeches were made. The object of the convention is to bring all the men closer together for the purpose of comparing notes and planning methods for handling the largely increased business.

The Philadelphia Pneumatic Tool Co., Philadelphia, Pa., builders of pneumatic tools, report that the amount of goods shipped by them in August surpassed all previous records. They have had large orders recently from the Cambria Steel Co., the Pennsylvania Steel Co., two large shipbuilding companies, and the Grand Trunk Ry. Co., and also a number of orders from foreign parts. They have just added quite extensively to the machinery in their machine shop.

The Lucas Machine Tool Co. Cleveland, O., manufacturers of horizontal boring, drilling and milling machines and power presses, are now occupying their new shop on Robison Ave., Cleveland. This has been entirely equipped with up-to-date tools, and the increasing demand for their product has made it necessary for them to consider a further extension.

Foote, Burt & Co., Cleveland, O., manufacturers of drilling machines. Cleveland, O., are just getting settled in their new shop, 1301-1303 St. Clair St. The building is 55 x 120, two stories, with boiler house outside, and contains a number of new machines, including a Dreses radial and several Reed lathes. A Maris electric crane has also been installed.

MACHINERY.

December, 1902.

THE RENOLD SILENT CHAIN IN CONNECTION WITH MACHINE AND STRUCTURAL TOOLS.

J. O. Nixon.

Recent articles in Machinery about motor-driven shops, current advertisements of motor-driven tools and the ever-present motor salesman, all remind the machine-shop manager that this is an age of electricity. If his shop is already equipped with motors, he can probably cite endless figures to show the correctness of his judgment in the particular system selected, and if he is only trying to decide on a system he is probably seemingly mixed up inextricably in figures on first cost, interest and depreciation, power factor, speed-regulation, etc.

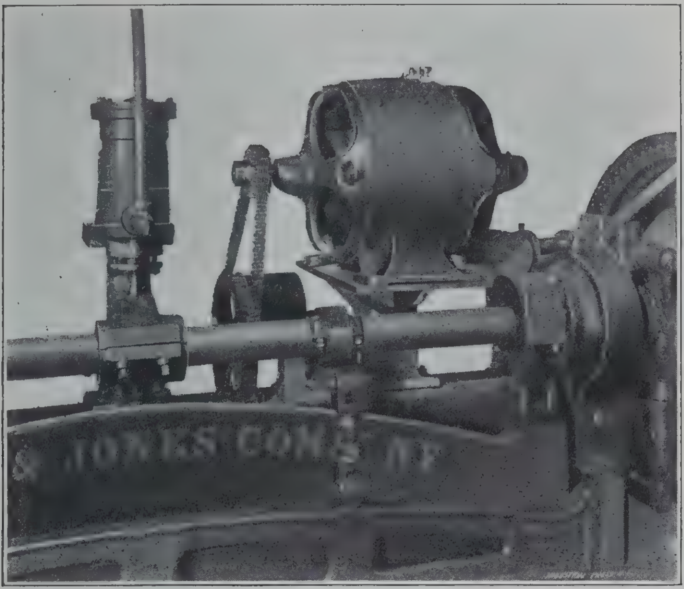


Fig. 1. Hilles & Jones Gate Shear. Driven by General Electric Motor and Renold Chain.

After the system to be adopted is decided on, there next arises the question of how far to carry the individual motor and when to start grouping small tools on line shaft. The character of the work to be done will have something to do with this decision. If the work is miscellaneous then the individual motor is desirable, because one of the greatest advantages to be derived from electrical drives is ease in speed control. If, however, the processes are essentially the same day after day, then countershafting and the group system may be desirable, having in mind always, however, the necessity for clear space for crane service.

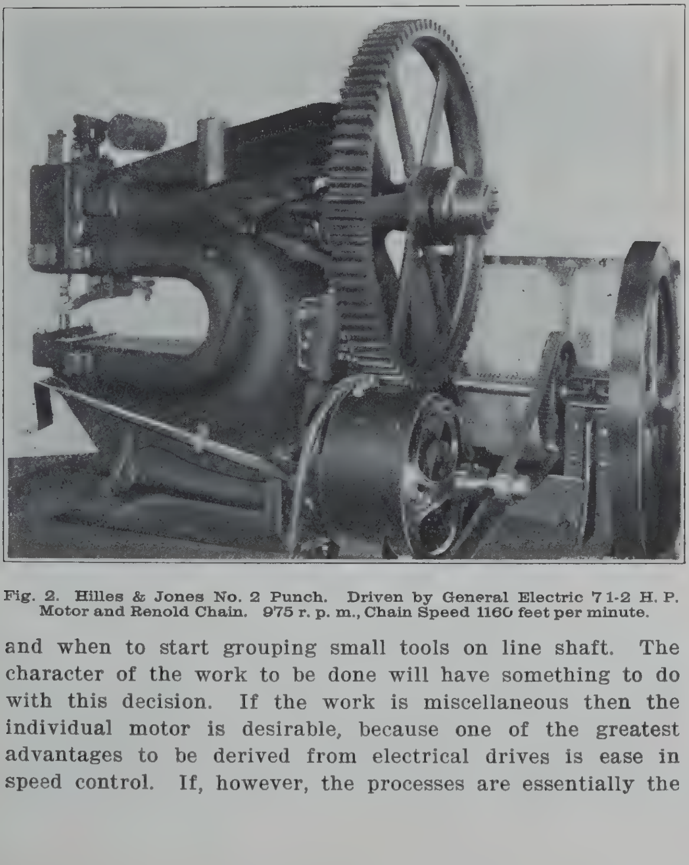


Fig. 2. Hilles & Jones No. 2 Punch. Driven by General Electric 7 1-2 H. P. Motor and Renold Chain. 975 r. p. m., Chain Speed 1160 feet per minute.

When a decision has been reached as to the most desirable distribution of the motors, the next problem is how to connect the motors to the tools and the line shafting. It is probable that when this point is reached many modifications of the original scheme will be necessary. There need be no surprise if tools designed before the direct electrical drive was thought of should present seemingly insurmountable difficulties in motor attachment. It is as a simplifier of these problems that the Renold silent driving chain is important. Its use in connection with machine tools may readily be divided into two classes. In the first it is used as an integral part of the machine, for driving the spindles and feeds and for the general transmission of motion within the ma-

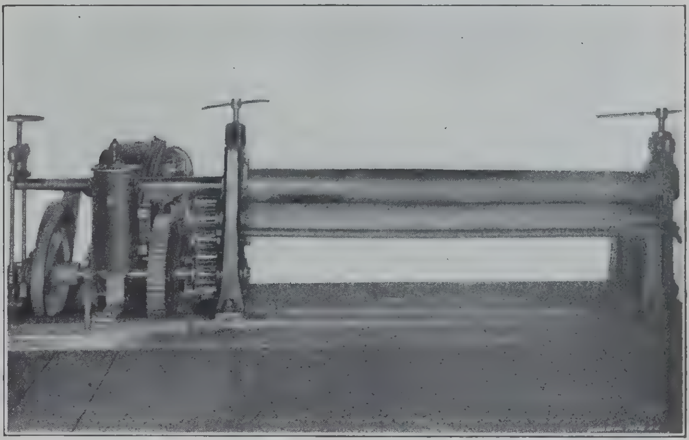


Fig. 3. Bending Rolls. Driven by Series Motor and Reversing Controller. 7 1-2 H.P. Motor, 750 r. p. m. Renold Chain Drive. Chain Speed 950 feet per min.

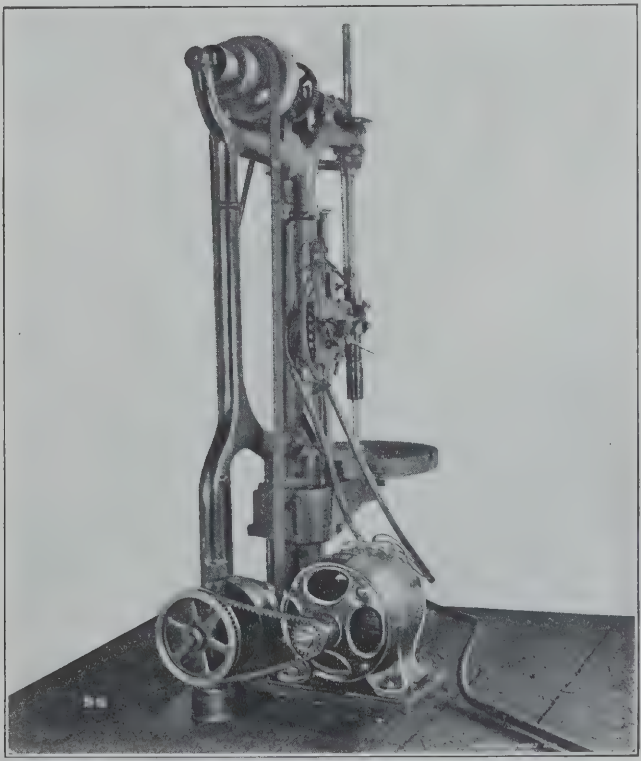


Fig. 4. Snyder Drill Press. Two-H.P. Motor, 1000 r. p. m. Renold Chain Drive. Chain Speed 1100 feet per minute.

chine itself. In the second it is used for driving the machine and with this last we are now concerned.

As has been inferred above, the application of motors to machine tools is sufficiently difficult where the tools are being designed for electrical drive; where motors are to be applied to old tools, the problem is greatly complicated.

The advantages of Renold chains for such work arises from their convenience and adaptability. For spur gearing the motor must be provided with an absolutely rigid support, rigidly attached to the tool. The center distance is dictated more or less by the gears and not by convenience. The noise made is generally objectionable. Rawhide pinions are often used and vary greatly as to durability. A worn raw-hide pinion, however, is noisy and also causes a chattering that tends to make the brushes jump, with a consequent burning out of the commutator.

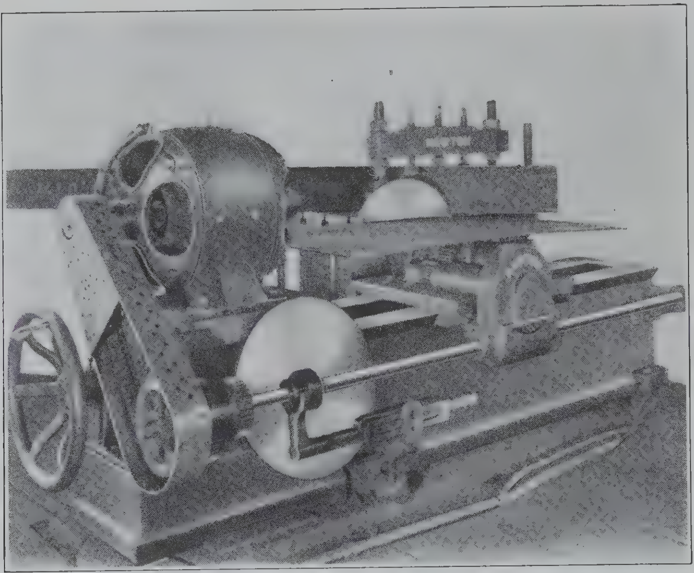


Fig. 5. Newton Cold Saw with Renold Chain Drive. Five H. P. Motor, 975 r. p. m. Chain Speed 1160 feet per minute.

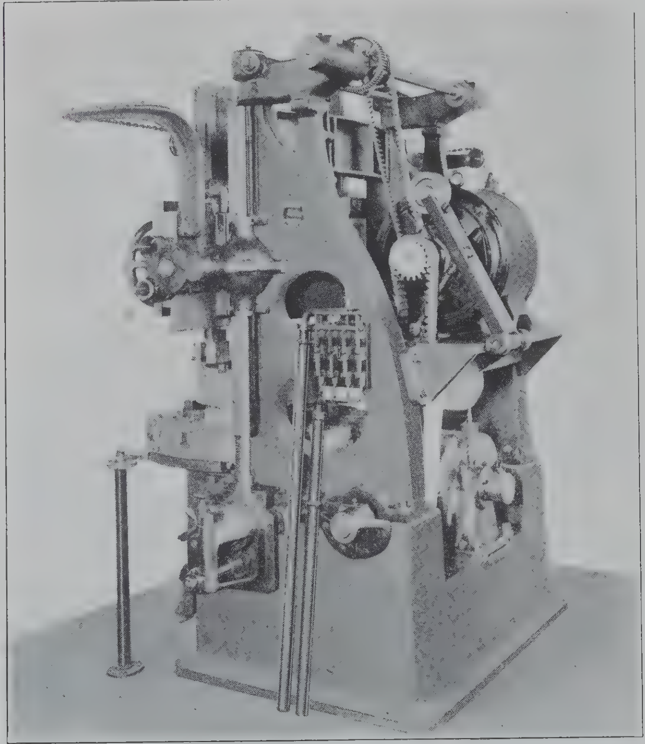


Fig. 6. Bullard 37-inch Boring Mill, Bullock Variable Speed Motor, Renold Chain Drive.

The other alternative to the chain drive is, of course, the belt. If a belt be run on short centers an idler must be used. with a corresponding loss of efficiency and convenience. A belt also lacks the advantage of positive connection possessed by spur and chain gearing. Many unexplained failures to get expected output are due to slipping belts. The Renold chain, in contrast to belts, or other method of connection, is thus silent, efficient, positive and convenient.

When it was decided to equip the shops of the Link-Belt Engineering Company electrically it was concurrently decided to do it in the best possible way in the light of the information then obtainable. Some things were done, of course, that would be done differently if the job were to be done again; but in the main the change has been eminently satisfactory from every standpoint. Every tool was studied as a separate problem, and it is now possible to show, by comparative records, the very substantial gains made by the change.

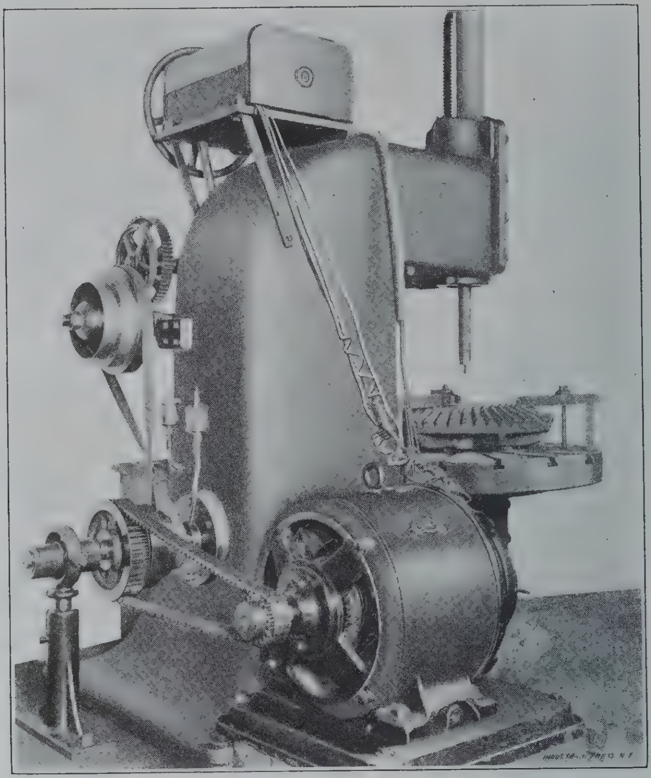


Fig. 7. Betts Car-wheel Mill, Motor-driven, Renold Chain Drive.

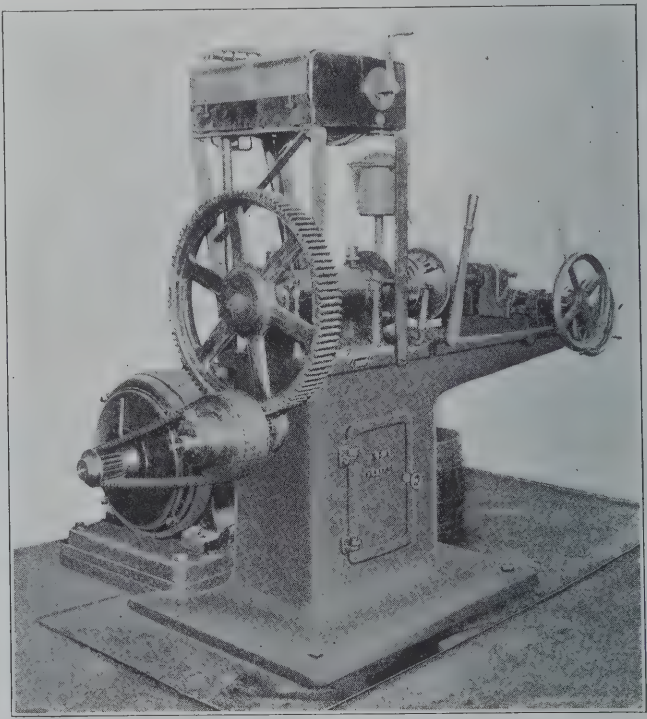


Fig. 8. Acme Bolt Cutter, Motor Driven, Renold Chain Drive.

At about the same time when the application of motors to the various tools was being studied out, this company began the manufacture of the Renold silent chain gear in this country. While a great deal of it is used in the shops, still nowhere is a foot used where it is not the best thing for

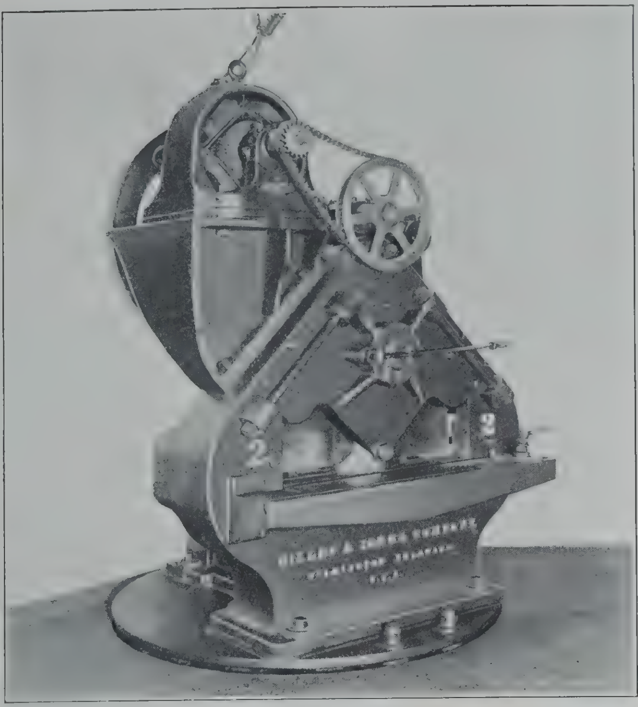


Fig. 9. Hilles & Jones Angle-iron Shear 10 H.P. Motor, 750 r. p. m. Renold Chain Speed 1190 feet per minute.

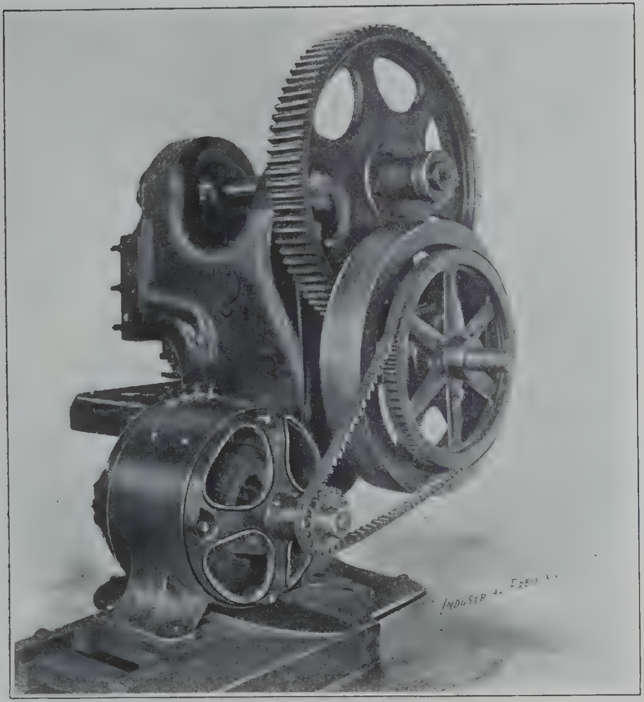


Fig. 10. Ferracute Punch, Motor Driven, Renold Chain.

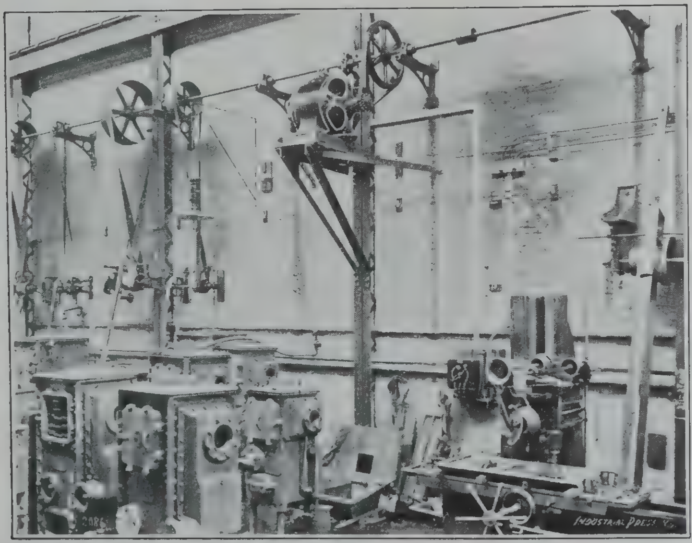


Fig. 11. Line Shaft Driven by 15 H.P. Motor and Renold Silent Chain.

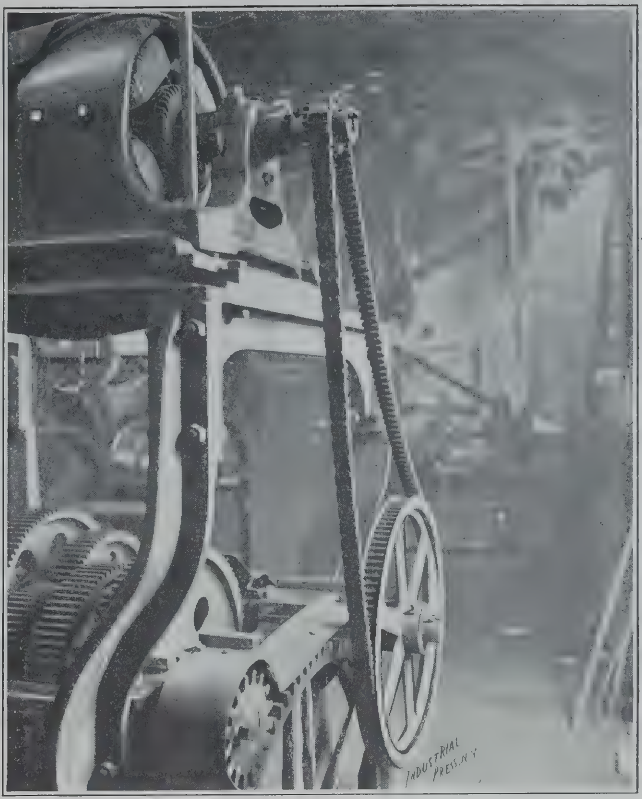


Fig. 12. Old Roll Lathe Driven by Westinghouse Motor, Renold Chain.

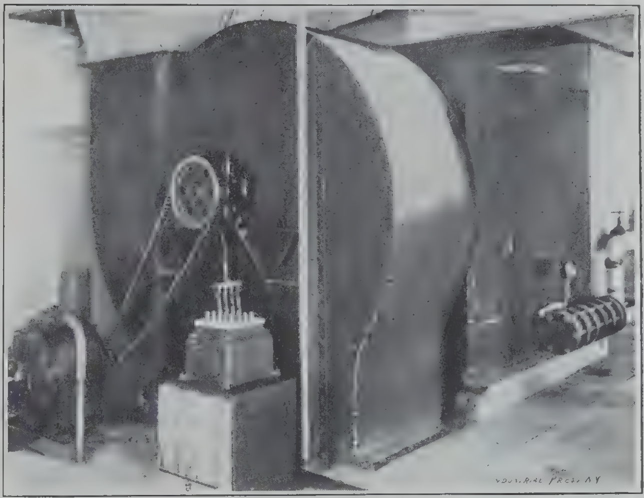


Fig. 14. Sturtevant Heating Fan, Motor Driven, using Renold Chain.

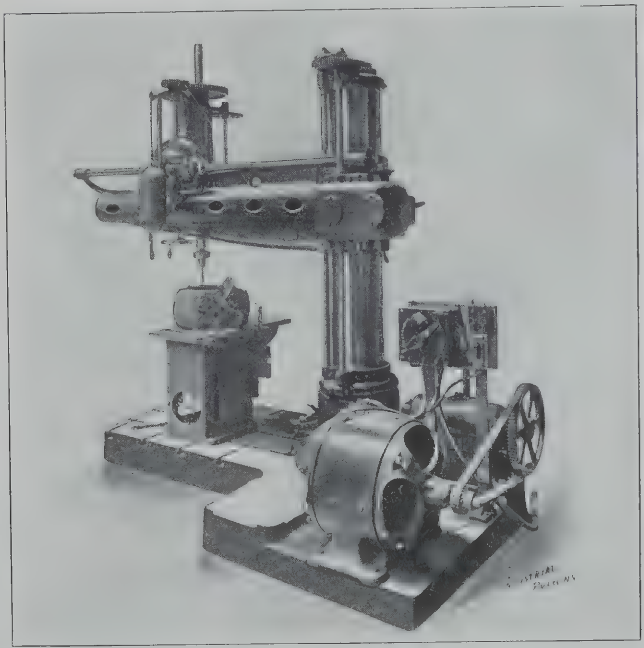


Fig. 16. Bickford Radial Drill, with Motor on Extension Base. Constant Speed Motor, Renold Chain Drive.

the place. There are belt drives and spur-geared drives, and while their number is small compared to the number of chain drives, it represents very fairly about the proportion that such drives should bear to chain drives in the ordinary shop.

Concisely stated, the advantages of the Renold chain are, that it may be run on shorter center distances than a belt and on longer centers than spur gearing. The center distances are dictated only by convenience and may be fixed, or the motor may be mounted on rails. The chain is silent; it is efficient; it is compact; the drive is absolutely positive and the calculated output is a certainty.

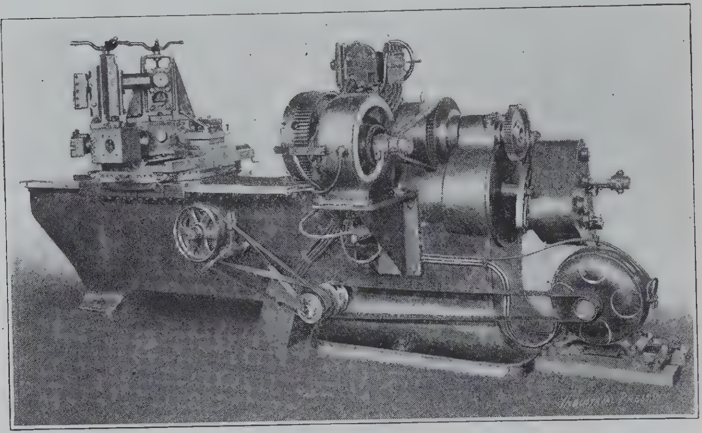


Fig. 13. Renold Chain Drive from Crocker-Wheeler Motor to American Turret Lathe.

The majority of the accompanying cuts are from photographs taken in the Link-Belt Engineering Co.'s works at Nicetown, Philadelphia. They are intended to show as large a variety of tools and motor applications as possible. In nearly every case the tools were originally belt-driven. In at least five cases the method shown for attaching the motor has been adopted by the builder of the tool as his standard. In the main, the photographs speak for themselves, but a few comments on some of them will not be out of place:

Figs. 1 to 10 inclusive show drives in these works. Most of those shown are on structural tools, which arises from the fact that many of the motors in the machine shop are below the floor and are therefore difficult to photograph satisfactorily.

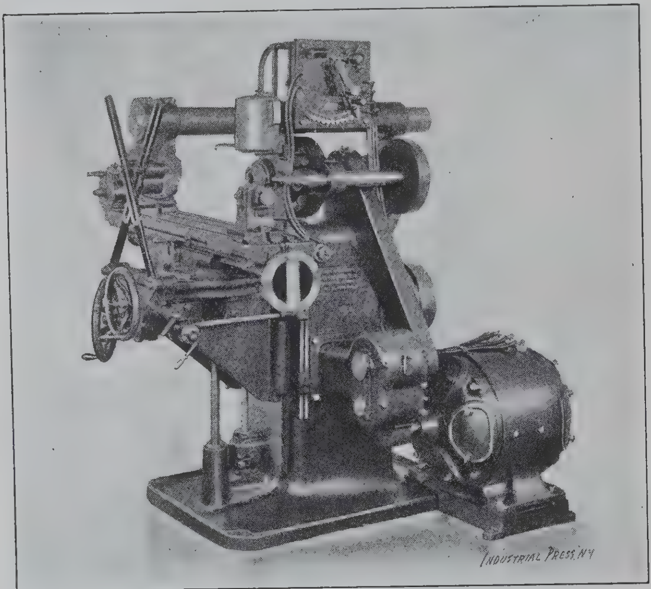


Fig. 15. Brown & Sharpe Universal Milling Machine, Renold Chain Drive Incased.

Fig. 1 shows a General Electric motor mounted on a bracket on a gate shear. The motor is out of the way and the drive is compact and simple.

Fig. 2 shows one of three punches similarly arranged. The General Electric motor is mounted on a cast bracket secured to the machine, making an absolutely self-contained outfit. The work of the chain on this intermittent service has been most excellent.

Fig. 3 shows a set of bending rolls. These were formerly driven by two belts and double clutches. The present arrangement, while thoroughly serviceable and much more easily handled than the old rig, is, at the same time, sightly, compact and efficient. This tool illustrates, perhaps, as well as any other, the possibilities of the Renold chain in converting old tools to the motor drive.

Fig. 4 shows a drill press, a type of several, all of which show increased output, because the chain does not slip.

Figs. 5 and 6 show tools as now supplied by the builders. The arrangement on the Newton cold saw (Fig. 5) was designed by the Link-Belt Co. and is now used by the Newton Machine Tool Works on motor-driven saws supplied by them. The method of attaching the motor to the Bullard 37-inch mill, shown in Fig. 6, was developed by the Bullard Machine Tool Co. It brings out in no less a degree than Fig. 5 the fact that a minimum change in the tool itself is necessary to attach the motor, where the Renold chain is used. It will be noted that the tool is standard in every way except for the addition of the motor base, which is held by the top bolts shown. This feature of building motor-driven and belt-driven tools from the same patterns is one much appreciated by the tool builders.

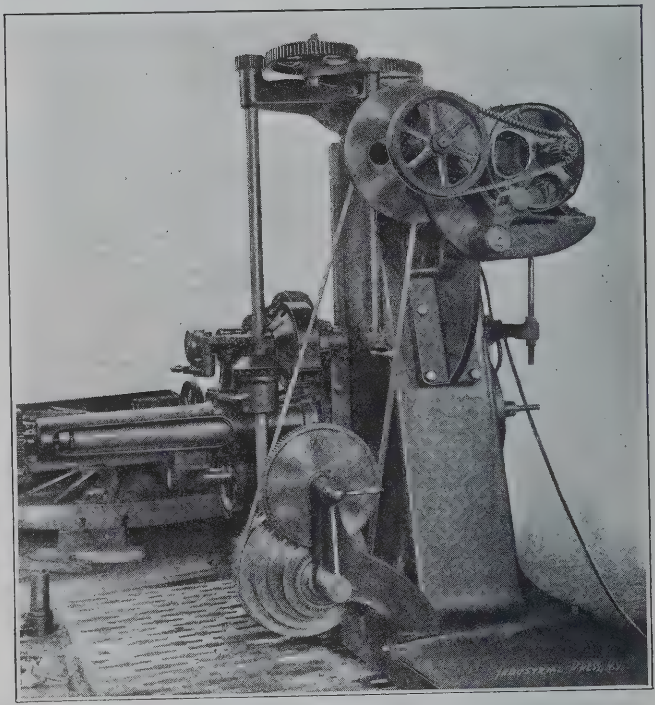


Fig. 17. Floor Boring Machine, Electrically Driven, Renold Chain.

Fig. 7 shows a Betts car-wheel mill with Bullock variable speed motor.

Fig. 8 shows an Acme threading machine with variable speed reversing motor. The superiority of this arrangement over the usual one, with two belts and two shifters, is obvious.

Fig. 9 shows an angle-iron shear driven by a Westinghouse motor. This was supplied with a spur-gear connection by the makers, there being one idle gear. Silent chain was substituted as an experiment and a saving of 15 per cent. in current was found. This was not altogether unexpected, because the efficiency of the silent chain gear is about 96 per cent.

Fig. 10 shows a Ferracute punch; motor on wood base.

The rest of the photographs were taken elsewhere, but show typical machine-shop practice.

Fig. 11 is a line-shaft drive.

Fig. 12 shows a motor-driven roll lathe.

Fig 13 shows a Crocker-Wheeler variable-speed motor connected to an "American" turret lathe.

Fig. 14 shows a heating fan drive.

Fig. 15 a standard Brown & Sharpe universal milling machine with encased Renold chain drive applied by the makers.

Fig. 16 shows a Bickford radial drill with a General Electric motor mounted on an extension to the base of the tool.

Fig. 17 shows an old floor boring machine converted to electric drive.

SHOP CONSTRUCTION.—3.

THE CHIMNEY OR STACK—ITS DESIGN AND CONSTRUCTION.

OSCAR E. PERRIGO.

Thus far our methods of construction, and the necessary materials for them have been such as are encountered daily by the architect and the builder. We now come to the erection of the chimney or stack, which has many peculiarities and restrictions on its design and construction, resulting from its narrow foundation, great height, and the necessity of its resisting not only the high wind pressures and great changes in temperature at different seasons but also the great difference of temperature on the inside and on the outside. It seems to us necessary, therefore, to treat this subject of chimney construction in a separate article, wherein we will consider the respective merits of and the objections to chimneys of the more common forms and materials.

Regarding the chimney built of brick, the principal objections would appear to be its first cost, which is considerable, and the fact that owing to its narrow base and great height very firm and solid foundations must be prepared. This, of course, becomes more difficult and expensive where the ground is soft and excavations must be made at great depth, or where piles have to be driven to build the foundation upon. At the present time many sheet-iron or steel chimneys are erected, and it is the prevailing idea that they are the more economical. About the only advantage they seem to possess, however, is that owing to their comparatively light weight they may be erected on superstructures upon which a brick chimney could not. Then too, their first cost is much less than for a brick chimney of equal capacity. Some of their disadvantages are, that they are very liable to rust at the seams and rivets, owing to the impossibility of keeping these points properly protected from water. Therefore they are comparatively short-lived. Again, in the effort to protect the metal they must be frequently painted, or coated with some of the numerous "cure-all" paints, "warranted to protect them perfectly inside and out;" and the use of *any* protective covering is a continual expense for maintenance to which the brick chimney is not subject.

The conclusion, therefore, must be that, if the life of the chimney is of less consideration than its first cost, we would adopt that constructed of sheet-iron or steel; but if we regard permanency and the ultimate outlay, both for construction and maintenance and all the advantages derived, brick is evidently the material to be chosen.

The height of the chimney will depend somewhat upon surrounding hills, high buildings and similar obstructions to the free course of the wind, but should never be less than the diameter of the internal flue multiplied by twenty. The diameter of the internal flue will depend on the aggregate areas of the smoke flues or "up-takes" leading from the boilers, and these necessarily depend upon the grate surface, allowing about 4.5 square feet per horse power. There are many methods of calculating the diameter of chimney flues, some of which are very complex and depend upon many assumed conditions at each step, which ofttimes have hardly more practical value than guesses. Others assume to calculate the volume of gases, the speed of their flow, the area of grate openings, etc., all of which might be changed with each sample of coal, or according to the condition of the weather. Practical engineers will probably favor the following simple method, even with its arbitrary assumptions, and will be quite successful in the practical application of it as it is the result of much actual experience. The horse power being given—say, in this case 470—and allowing 4.5 square feet of grate surface per horse power, we have 104.4. At 5 pounds of coal per horse power, which is quite liberal, we will burn 2,350 pounds of coal per hour. Our chimney is 100 feet high. We divide the pounds of coal burned per hour by the square root of the height multiplied by 12 ($10 \times 12 = 120$) and we have 19.58 as the area of the chimney flue, in square feet. Divide this by .7854 and extract the square root and we have the diameter, slightly less than 5 feet. Having the diameter of flue and height given we may by inverse methods obtain the horse power, grate surface, etc. In making these calculations we should be sure to get capacity enough; for if the chimney is a little too large no harm is done, while if a little too small a serious expense is incurred for a supplementary one.

All chimneys over 75 feet high should be built with a central "core," or flue, preferably of circular form, surrounded by an outside casing sufficiently strong to properly support the inner core and to resist the pressure of the strongest winds. The thickness of the walls of both the outer portion and the inner core should be sufficient to be very rigid near the ground and gradually thinner as the walls rise, the "breaks" being, of course, on the inside of the outer portion and the outside of the inner core. These breaks are usually four inches, or the width of a brick at each step. The "batter," or inclination of the outside face of the main structure should be a quarter of an inch per foot. In our case we are supposed to require a chimney 100 feet high, with a circular flue five feet in diameter.

In the sketches, Fig. 1 illustrates a vertical section through the center of the chimney and its foundation. It shows the thickness of walls, special form of central flue, retaining caps at the top, and special arrangements for increasing the draft. Fig. 2 is an elevation of the exterior, showing its general form and appearance when completed. Fig. 3 shows a horizontal section through the octagonal portion on the line *AA*, Fig 1. Fig. 4 shows a horizontal section through the square base, on the line *BB*, Fig. 1. Fig. 5 illustrates, on an enlarged scale, the number of bricks necessary for a course, if the square form were to be continued to the top. Fig. 6 shows the economy of adopting the octagonal form, as saving material and labor, and offering considerably less surface to wind pressure from certain directions.

In the Figs. 5 and 6 the upper half shows the laying of a "header" course and the lower half the laying of a "straight" course. In these two sketches it will be seen that in a header course, the octagonal form contains 52 bricks less than the square form; and in a straight course 32 bricks are saved. Assuming five courses per foot in height, and that in each foot we have one header course, we save by the octagonal form 180 bricks. This, of course, is less as we approach the top, but the average saving will be considerably over 100 bricks per foot, or over 8,000 for the whole work. Actual experience shows that the extra labor cost of making the many corners is more than balanced by the smaller number of bricks laid in the octagonal form than in the square form. The appearance is much enhanced and the wind pressure is considerably diminished by getting rid of the projecting corners.

The base of the chimney is of square form, this being more convenient for the introduction of the smoke flues or "uptakes" from the boilers, the placing of the ash doors and the general appearance. The ash door is shown in Fig. 2. The opening should be arched, preferably of semi-circular design, as affording the most strength to sustain the great weight of brick-work over it. It should be closed with a sheet-iron door. The openings for smoke flues should also be strongly arched, similar to the ash doorways. From the square portion at the base, the main shaft of the chimney is of octagonal form, as indicated in Fig. 4.

For foundations the earth should be excavated to perfectly hard ground, making a pit 28 feet square; that is, twice the depth of the foundation, assuming that in consequence of the condition of the ground it is necessary to excavate to a depth of 14 feet. In this pit should be a bed, 4 feet thick of large stones laid in strong cement mortar. Upon this should be courses about 18 inches thick and gradually drawn in at the top to 16 feet square. By strong cement mortar we mean that containing two parts cement, one part of lime, and about three parts of clean, sharp sand. The amount of sand will vary considerably with its fineness, sharpness and its freedom from dirt; the finer the sand the greater the quantity that must be used.

In erecting the central core and the outward supporting structure great care should be used to make all joints of uniform thickness, and to see that as the courses are laid on, they are frequently leveled. "Batter plumbs" should be used

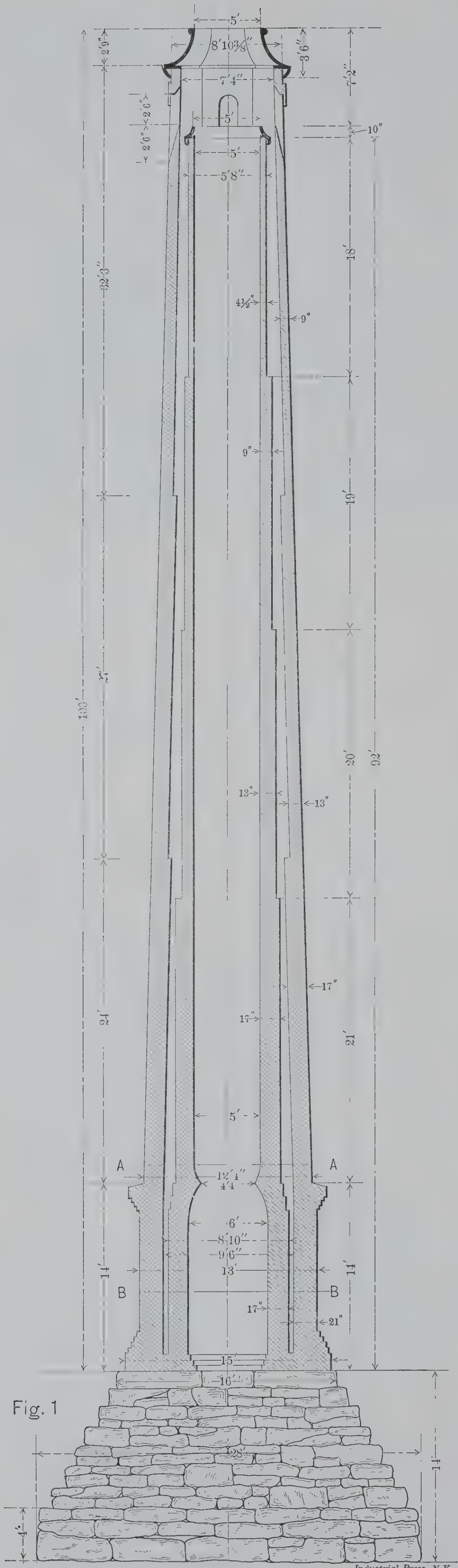


Fig. 1

Industrial Press, N.Y.

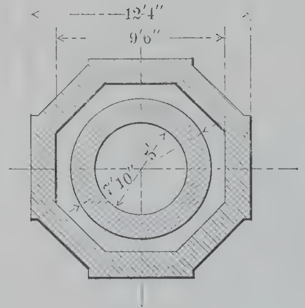


Fig. 3

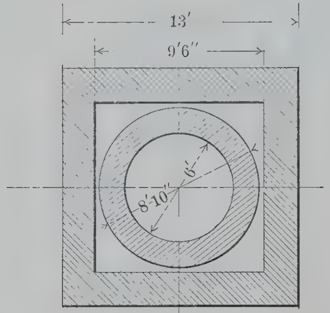


Fig. 4

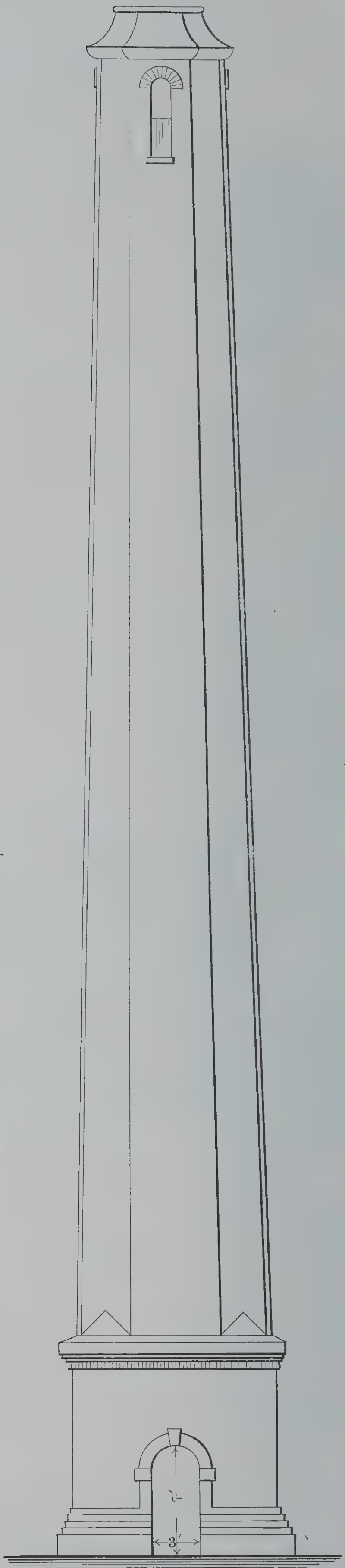


Fig. 2

Figs. 1 and 2. Sectional and Exterior Elevation of Chimney. Figs. 3 and 4. Horizontal Sections through A A and B B.

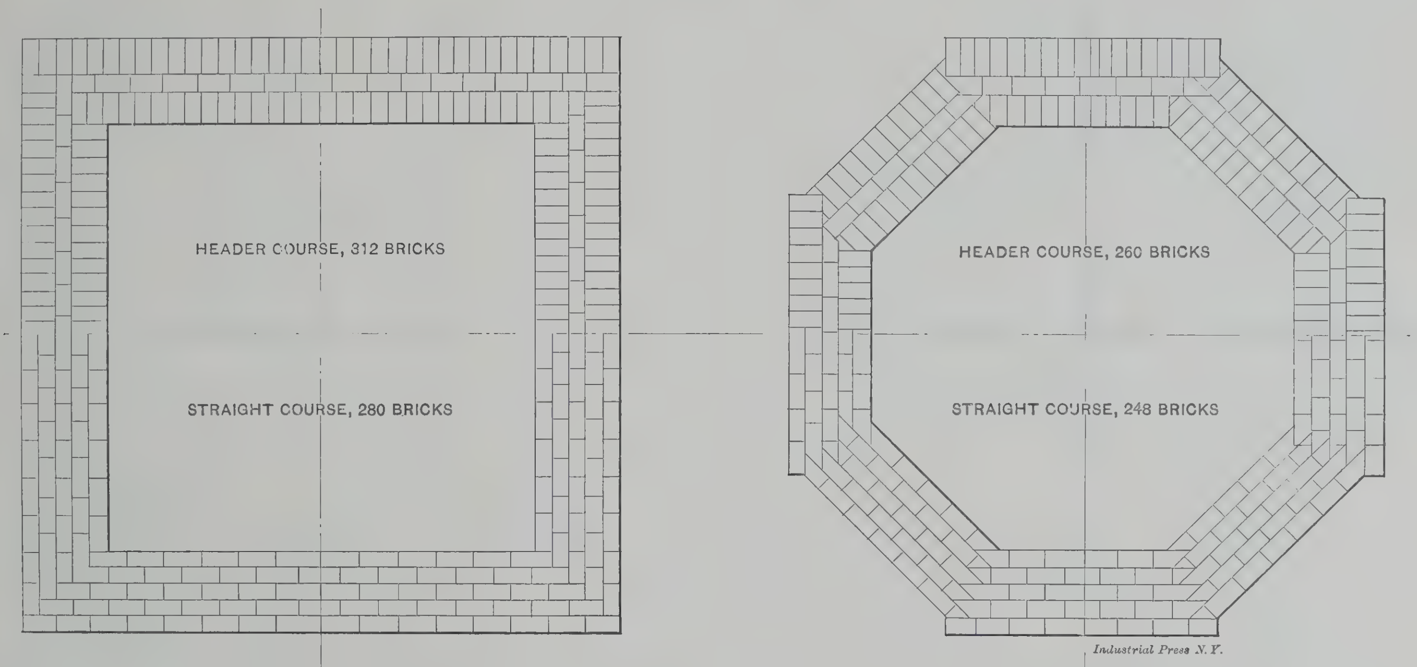
for the outside; that is, the board on which the plumb line is attached should have the batter or inclination by being made narrower at the bottom. For instance, a plumb board four feet long should be six inches wide at the top and four inches at the bottom (the batter being equal on both edges).

Another matter that must be scrupulously attended to is that of properly supporting the inner core. It will not do to lay bricks from wall to wall so as to tie them together, as the expansion and contraction of the inner core would soon ruin the structure. The support is given by building up into the outer wall inwardly projecting bricks reaching half way across the space, and against these, others projecting outwardly from the inner core. These should be placed on all eight sides, in the same course, and at intervals of not over eight feet through the entire height.

The form and thickness of walls and the heights of the "breaks" are shown in Fig. 2. The central flue is formed after the model of the well-known student lamp and forms a very effective combustion chamber for escaping smoke. It is the form adopted by a prominent engineer who built a large number of chimneys of this design which have been in successful use for many years.

The smoke flues enter the chimney below the constricted portion of the inner flue. The top caps are of cast-iron and may be made in sections and bolted together, as well for convenience in erecting as for economy of pattern making. That on the inner core terminates 7 feet 2 inches below the top of the main cap. At four sides of the outer structure are openings, as shown in Fig. 1, the bottom of each opening being on a level with the top of the inner cap. By this means the current of air which always rises along any high wall is taken advantage of, as it passes up the side of the chimney, into these openings, and out the top of the chimney, and creates a partial vacuum over the top of the central flue, thus considerably increasing the draft. Means should be provided for reaching the top of the chimney, as the iron caps will need painting, or lightning rods may have to be placed or repaired. Iron ladders up the side may be fastened to the wall, or a permanent block may be attached to the main cap and provided with a wire rope, for this purpose.

As a matter of safety from lightning it is well to provide lightning conductors. A round copper rod of not less than ⅝-inch diameter, or one of equal area of cross section, may be run up outside of the chimney, through heavy glass insulators, and terminate four feet above the main cap in four points, 5-16-inch diameter or equivalent area. The lower end of the rod should go into *moist* earth and be attached to a cast-iron plate 30 inches square and ¾-inch thick.


HEADER COURSE, 312 BRICKS
STRAIGHT COURSE, 280 BRICKS
HEADER COURSE, 260 BRICKS
STRAIGHT COURSE, 248 BRICKS
Industrial Press N.Y.

Figs. 5 and 6. Laying the Header and Straight Courses of Brick in the Square and Octagonal Sections.

STEEL AND ITS TREATMENT.—4.

HARDENING BATHS.

E. R. Markham.

When steel is heated to the proper hardening heat it is plunged into some cooling bath to harden; the rapidity with which the heat is absorbed by the bath determines the hardness of the steel. Knowing this, it is possible by the use of baths of various kinds to give steel different degrees of hardness and toughness. A bath that will absorb the heat contained in a piece of steel the quickest, will make it the hardest, everything being equal.

A bath of mercury will cause a piece of steel plunged into it to be harder than if the steel were plunged in any of the liquids commonly used for this purpose. But as a bath of mercury would be extremely expensive it is but little used.

Clear cold water is the bath more commonly used than any other, and for most cutting and similar tools gives good satisfaction; although many old hardeners claim better success with water that has been boiled, or that has been used for some time, provided it is not dirty or greasy.

A very excellent bath that is used almost universally is made by dissolving all the salt possible in a tank of water. Salt water, or brine as it is commonly termed, is used in most shops on certain classes of work and in some shops it is used altogether when a bath of water is desired.

Various kinds of oil are used to accomplish various results. When small or thin cutting tools requiring a hard cutting edge are to be hardened, a bath of raw linseed or neatsfoot oil is used. When toughness is the desired quality, as in hardening a spring, a bath of tallow, sperm oil or lard oil is used.

But the nature of steel of different makes varies so much that no one bath answers best for all purposes, or for the same purpose when applied to steels of different makes.

Sometimes it becomes necessary to use a bath containing two or more ingredients in order to accomplish the desired result.

I have in mind a manufacturing concern who made a great many heavy springs. Until they changed the make of steel they had been using for years they had excellent results from hardening in lard oil; but after changing they could do nothing with this bath. After considerable experimenting, they were advised to use the following mixture:

Spermaceti oil	48	parts
Neatsfoot oil	45	"
Rendered beef suet	4	"
Resin	3	"

They had very good results with their bath until a drummer came along with good cigars, and a steel 2 cents a pound cheaper, and then trouble was the result.

By the way, I have visited and known of several shops where a few good cigars, or an occasional wine supper, which some glib-tongued salesman was willing to put up for the man who did the buying, caused more trouble in the hardening department than a little.

But, to return to the hardening of the springs, when the *new* steel came, the springs would not harden satisfactorily in the mixture mentioned. They were finally advised to try a bath of boiling water and this worked very nicely.

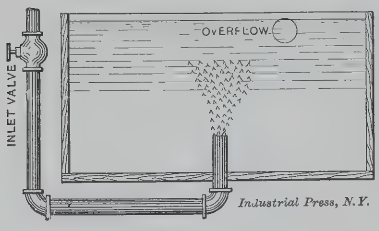


Fig. 1.

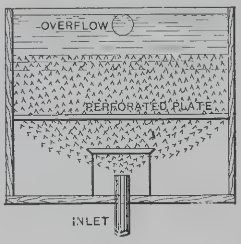


Fig. 2.

Very small cutting tools such as taps, reamers, counterbores, etc., harden very nicely in a bath made by dissolving 1 pound of citric acid crystals in 1 gallon of water.

The following bath is recommended where it is desirable to have the tool *hard* and *tough*:

Salt ½ teacupful; saltpeter ½ oz.; pulverized alum 1 teaspoonful; soft water 1 gallon.

The following bath gives excellent results, but care must be exercised in its use as it is deadly poison.

To 6 quarts of soft water add 1 oz. corrosive sublimate and 2 handfuls common table salt. When dissolved it is ready for use.

Sulphuric acid is added to water in various proportions from one part acid to ten parts water, to equal parts of acid and water—some even using clear acid. But although excellent results, so far as the hardened surface is concerned, may be obtained by employing this acid, steel makers do not advocate its use, claiming that the after effects are injurious to the steel. And the writer's experience substantiates the claims of the steel makers. I do not advocate the use of any of the acids which act on steel, provided any other form of bath will give satisfactory results.

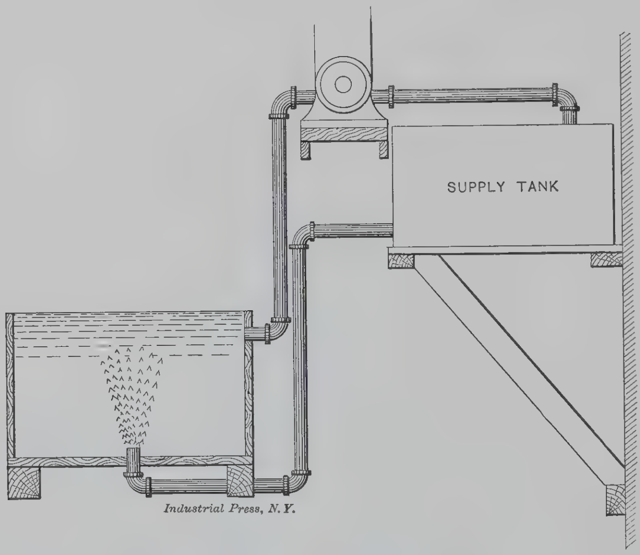


Fig. 3. Hardening Bath with Circulating Pump.

There are many other compounds used with success in various shops, but their number is legion, and if I were to give all the different baths I have used, and seen used, it would be necessary to devote several articles to this subject.

As a rule a tool steel fit to use for cutting tools will harden in a satisfactory manner in clear water. If the outline is irregular, or it is desirable that it should be *extra* hard, a bath of brine answers admirably.

Articles of an irregular shape, made of steel liable to crack when hardened, should be dipped in warm water or brine, the temperature of the bath depending on the liability of the piece to crack.

Such tools as milling cutters, made from high carbon steels, are oftentimes hardened to advantage in a bath of water having one or two inches of oil on the surface.The article is brought to the proper temperature in the fire and immersed in the bath, passing down through the oil into the water. Enough oil adheres to the red hot steel, especially in the corners of the teeth or projections, to prevent the water acting as suddenly as it otherwise would, thus doing away in a great measure with the tendency to crack.

It is a good plan when hardening large pieces of almost any shape, if they are first dipped in water or brine, to allow them to remain in this liquid until the surface is hard, then remove and instantly plunge in a tank of oil, allowing them them to remain in the oil until cold. This works especially well in case of such tools as cutters, punching press dies, etc., where it is not necessary that the hardened surface be very deep; the depth to which the piece is hardened depending on the length of time it is left in the water. For most purposes old hardeners allow the article to remain in the water until it ceases to "sing;" this is the peculiar noise occasioned by putting a piece of red hot steel in water. When the piece stops singing it is removed from the water, plunged into oil and left until cold.

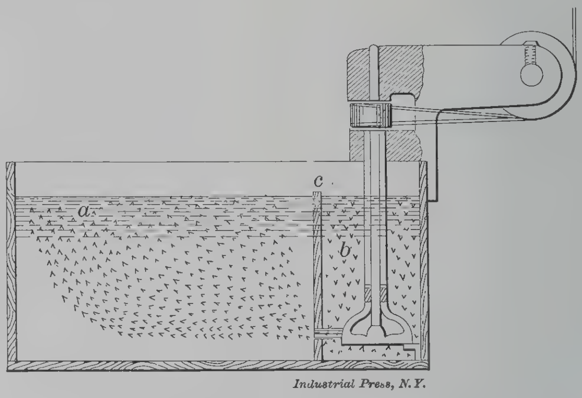


Fig. 4. Hardening Bath with Mechanical Agitator.

When pieces are to be hardened, and it is necessary to harden the inside walls of a hole or some depression, as the face of an embossing or forming die, or any similar piece, it is necessary, if good results are desired, to have a bath which has a stream or jet of water coming up from the bottom as shown in Fig. 1. If clear water is used in the bath, the inlet pipe may be connected with some constant supply, but if brine or some solution is used it becomes necessary to have a supply tank and use a pump, as shown in Fig. 3. The contents of the bath are pumped into the supply tank and run down the supply pipe by the force of gravity.

At times it is desirable to have a bath in which there is no gush or jet of fluid, but where the contents of the bath are kept in motion in order to force the steam away from the surface to be hardened. There are a number of ways of accomplishing this. Fig. 2 shows a bath having a pipe coming up from the bottom. The jet strikes a plate which spreads the fluid, after which it comes to the surface through the perforated plate.

Fig. 4 shows a bath in which the contents are kept in motion by some mechanical means contained in the tank. Such a bath may be made by following the instructions given in reference to Fig. 4. A tank of any convenient size may be made having a partition as shown at *c;* the portion of the tank marked *a* is intended to be used for the immersion of the articles being hardened, while *b* contains a pump, Archimedian screw, or some similar device for forcing the water into the side *a*. If a pump is used the water is forced through the pipe shown; if an Archimedian screw, the partition *c*, does not extend way to the bottom and the water is forced under it. In either case it returns to *b* over the top of partition *c*, as shown, thus insuring a rapid circulation of fluid. This form of bath is especially to be desired where brine or some favorite hardening solution is used. It is also possible to heat the contents of the bath when it is considered advisable, as is the case where articles are to be hardened that are liable to crack from contact with extremely cold liquids. Much more uniform results may be obtained, especially when small, thin pieces are hardened, if a uniform temperature can be maintained in the bath. As the surface of the bath is coated with ice in winter, the fluid is luke-warm in summer, and the temperature is anywhere between warm and extreme cold, depending on the condition of the atmosphere; it will readily be seen that uneven results must be the consequence. In order to be able to keep the contents of the bath at somewhere near a uniform temperature a small coil of steam pipe may be placed in the tank, and a thermometer may be used so as to readily show the condition of the bath.

While it may seem unnecessary to be so particular about the temperature of the bath—and it is unnecessary on most work, as an experienced hardener can determine the temperature near enough by the sense of feeling—yet there are jobs where it is essential that a certain uniform temperature be maintained in order to get uniform results. I do not mean by this that it is practical to attempt to keep the temperature within a few degrees of a given point but it can be kept somewhere near in order to get the best results possible.

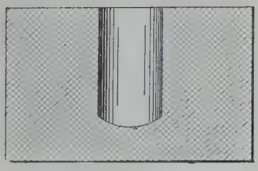


Fig. 5.

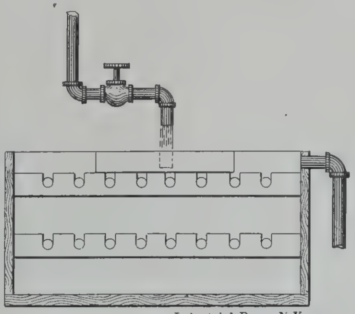

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Fig. 6.

At times it is necessary to harden the walls of a hole that does not go way through the piece, such as a die used for compression work, or some forms of dies for striking up cylindrical pieces. Fig. 5 shows a sectional view of a die having a hole running part way through it, as described. Now, if a piece of work of this description were hardened in a bath whose contents were not agitated it is doubtful if the walls of the hole would be hardened in the least, as the steam generated would blow the liquid out of the hole and none could enter until the steel was cooled to a point where it could not harden. Better success would follow if it were dipped in a bath having a jet of water coming up from the bottom of the tank; but in this case it would be necessary to invert the piece in order to get the liquid to enter the hole, and if it were deep it is probable that enough steam would rise in the hole to keep the contents of the bath from affecting the walls near the bottom. Now, in order to get satisfactory results when hardening work of this character, it will be found best to have a bath so constructed that the liquid can be run into the hole by means of a faucet or pipe, as shown in Fig. 6. If the hole is deep and there is danger of the steam preventing the liquid effectually working at the bottom, a pipe may be run nearly to the bottom, as shown in sectional view, Fig. 7. The pipe must not be nearly as large as the hole or the results will not be satisfactory.

Sometimes it is necessary to harden several pieces of a nature whose outline betokens trouble if they are dipped in a cold bath, and yet it seems necessary to use a cold bath in order to get the desired result. Take for instance, a shank mill of the shape shown in Fig. 8. If this mill is heated to the proper degree of heat and plunged in a dish containing just enough water or other liquid to harden the teeth before the water gets hot, the teeth will harden in a satisfactory manner and the water will heat so as to do away with any danger of cracking from internal strains. The size of the dish will determine the depth of the hardening. When one piece is hardened the dish may be emptied and filled with cold water for the next. I have seen this method used with excellent results, not only on milling cutters, but on broaches, dies, etc., that showed a tendency to crack when dipped in a *large* bath of *cold* fluid. Of course, it must be borne in mind that the dish selected for the bath must be large enough to hold a sufficient quantity of liquid to harden the piece the necessary amount, before it becomes too hot; but it is essential that it should not be too large for the contents to heat, because then there is no difference in its action from that of a large bath.

Baths for Case-hardening.

The design of the bath used for cooling work being case-hardened must be such as will adapt it to the work being hardened.

Where work is case-hardened in large quantities it is customary in most shops to heat the work in iron boxes; when the work is in the proper condition the box is inverted over a tank of water or other fluid, and the contents dumped into the bath. If the pieces of work are large or bulky and the tank is shallow they reach the bottom of the bath while red hot and as a consequence the side of the piece that lies on the bottom will be soft. In order to overcome this trouble the tank must be made deep enough so the pieces will be chilled before reaching the bottom. If it is not considered advisable to have an extremely deep tank, and the pieces are large, various ways are taken to insure the pieces hardening. One method which the writer has used with excellent results is to have a series of rows of wire rods reaching across the tank, no two consecutive rows being in the same vertical plane. The work as it descends into the bath strikes these wires, thus turning over and over and bringing all portions in contact with the contents of the bath. These wires also separate the pieces from each other and from any packing material which may have adhered to them.

The wires also retard the progress of the articles, thus giving them more time to cool before reaching the bottom of the bath. In order to insure good results it is necessary to have a jet of water coming up from the bottom of the tank and an outlet provided near the top for an overflow. The overflow pipe should of course be larger than the inlet pipe, and should be located far enough below the top edge of the tank so that the contents of the tank will not overflow when a box of work is dumped into it.

In order to be able to get the hardened pieces out of the bath readily it is necessary to provide a catch pan as shown in Fig. 9. The bottom of this pan should be made of strong wire netting or a piece of perforated sheet metal, preferably the former. The holes in the pan allow the packing material to fall through to the bottom of the tank and will also allow the water from the supply pipe to circulate around the work and to the top of the bath. This catch pan should be provided with strong wire handles, as shown, in order to raise the pan.

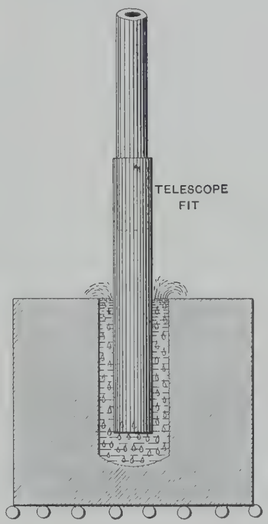

Fig. 7.

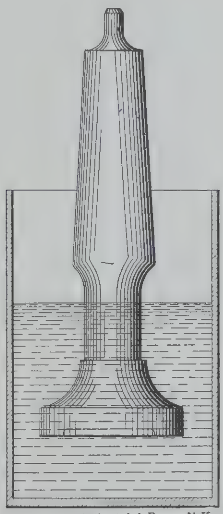
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Fig. 8.

I was at one time requested to call at a shop where they were having very unsatisfactory results with their case-hardening. An examination showed they were dumping their product into a barrel of water to harden. The box containing the work was inverted over this barrel and the work and packing material went into the water in a lump. Some of the pieces that happened to get out of this mass were cooled sufficiently to harden somewhat but the majority of the pieces were soft, or else they were hard on one side and soft on the other. An examination of the bottom of the barrel showed it to be considerably charred; in places the outline of the pieces was plainly visible, where the pieces had reached the bottom while red hot and had burned their way into the wood. It is needless to say that the side of the piece of work which was down did not harden. As the concern did not think it advisable, considering the limited amount which they had to case-harden, to get a tank of the description shown in Fig. 9, we made a catch pan as described, blocked it up about 6 inches from the bottom of the barrel by means of four bricks. We then bored a hole through the bottom of the barrel, screwed in a piece of pipe and by this means we were able to connect an ordinary garden hose so as to get a jet of water coming up from the bottom. As the barrel was out of doors we simply bored a 2-inch hole about 4 inches from the top of the barrel for an overflow and let the water run onto the ground.

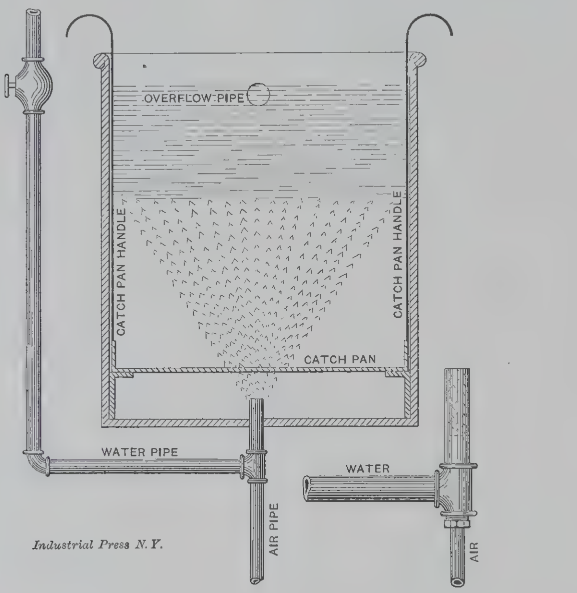

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Fig. 9. Case-hardening Bath having a Catch Pan to facilitate removal of the Work.

When the work was ready to dump we sifted it out of the box into the water gradually, instead of dumping it in a body. As soon as the box was emptied we grasped the wire connected with the catch pan and raised and lowered the pan in a violent manner in order to separate any pieces that might have lodged together. The result was very satisfactory and I think they are using a barrel to this day.

Where large quantities of work are hardened, baths are made with some means of keeping the work in motion after it reaches the bottom of the bath. Sometimes this is done by mechanically raising and lowering the catch pan and at the same time turning it around. Then again it is done by means of several sweeps which are attached to the lower end of a vertical shaft, the shaft resting in a bearing in the center of the catch pan. These sweeps or arms revolve and keep the pieces in motion, turning them constantly, but unless arranged properly they have a tendency to gather the work in batches thereby *undoing* what they are intended to do. Then again they have a tendency to scratch the surface of the work, which is a serious objection if color work is wanted.

When it is desired to get nice colors on case-hardened work, an air pipe may be connected with the bath as shown in Fig. 9, the water and air entering the bath together.

While it is not advisable to let air come in contact with pieces to be hardened for colors, while passing from the box to the water, yet the presence of air in the bath will have the effect of coloring the work nicely.

The air should enter in such a manner as to insure its reaching all parts of the bath. The pipe should be considerably smaller than the inlet water pipe and should extend a short distance up into it in order to prevent the air and water working against each other. A connection should be made as shown in detail. The writer does not suppose it will ever be necessary for many readers of MACHINERY to construct *all* the different bath tanks mentioned or find it necessary to construct these precisely like those shown. But some form or a modification of it will be found to fill almost any requirement in the ordinary shop.

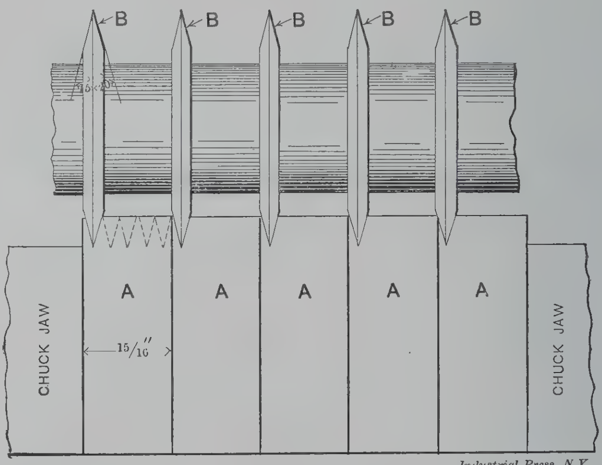
* * *

ANGULAR MILLING AND PLANING JOBS.

At the shop of the Falkenau-Sinclair Machine Co., Philadelphia (formerly A. Falkenau), an angular milling job was done recently that was somewhat difficult and out of the ordinary class of milling operations. More properly, in regard to the difficulty of the job, it was found practically impossible in one jobbing machine shop where it was tried, presumably because of inadequate fixtures; but it was comparatively easy when done with good tools and fixtures and in accordance with sound machine shop practice.

The job was milling five narrow angular grooves in one edge of a number of steel pieces 28 inches long, 2½ inches wide and 15-16 inch thick. The grooves were 3-16 inch wide and 5-16 inch deep and were carried to a sharp angle at the bottom. The steel pieces were for work of a special character the nature of which makes no difference in this connection except that it required the grooves to be quite exact and smooth, with no ragged edges at the tops. As indicated in the accompanying cut the sides of the grooves were sharply inclined, the included angle being 35 degrees. One side of the grooves made an angle of 20 degrees with the medial line and the other, 15 degrees.

In the shop referred to, that failed on the job, an attempt was made to mill the grooves successively with a single cutter while the piece was held in a milling machine chuck having narrow jaws. As a consequence the piece, of course, overhung the jaws a considerable amount on each side, which condition produced a peculiar result, but one that would have been predicted by anyone familiar with the characteristics of the stock used—cold-rolled steel. Cold-rolled steel has a surface under considerably more compression than the interior. In fact the interior is in a state of tension which causes the state of compression in the surface. If one side of a cold-rolled bar is planed off, the ends will curve toward that side when the clamping bolts are loosened. The first groove was cut along one side and the second one next to it and so on until the last one, when it was found that the piece had assumed a rainbow shape and that the last groove cut was the only one that was straight, the others all having a curvature increasing up to the first one milled, which had the most. The explanation is simple, of course. The first cut reduced the amount of stock on that side and as the chuck jaws offered but little restraint the stock curved toward that side slightly, the curvature increasing with each cut. The remedy for this action was simply to use a heavy milling machine chuck having extra long jaws which embraced nearly the full length of the pieces and held them perfectly straight until all the grooves were milled. Then there was little or no tendency of the pieces to curve in either direction; and if they did slightly, the grooves would remain parallel, which was the principal consideration.



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A Job of Angular Milling.

After it had been demonstrated that the grooves could be successfully milled, it was decided to mill a number at once, using gang cutters. Strange to say an eminent tool-making firm which furnished the cutters, recommended that the cutters be ranged side and side so that, say, the five grooves in one piece would be milled at one pass. This was found to be impracticable on account of the chips wedging between the cutters and causing rough, ragged edges at the junctures of the grooves; and the plan of mounting as illustrated, was adopted, the cutters *B*, *B*, *B*, *B*, *B*, being spaced apart the width of the pieces *A*, *A*, *A*, *A*, *A*, so that the successive cuts of each cutter were taken in each piece in the same relative position. This plan worked quite successfully.

In connection with the same contract a planer job of unusual character was done. It was grooving the top of a steel casting 16 feet long, 44 inches wide and perhaps 10 inches thick, with V-grooves of the same shape as those milled by the milling machine. The grooves were smaller, however, being about 20 to the inch. These grooves were planed with a gang tool, the cutters being spaced apart on the same principle as the milling cutters, that is, so that the chips of adjacent tools would not interfere. After the grooves were planed they were rolled, to produce a smooth surface, with a gang of steel rollers held by a holder in the tool-post. After rolling, the whole surface was polished with oil and emery, the workmen using pine sticks endways of the grain, for rubbers. A remarkable feature of this job was the freedom from blowholes, sand pits and flaws in the steel casting, the surface being perfect in this respect. It showed that steel founding has reached a high state of art in America when large steel castings of this shape can be made with a surface as free from flaws as rolled plates.

* * *

An Illinois Central Railroad freight car, fitted with ball-bearing axles, has been subjected to a test trip of 2,600 miles, carrying a load of 80,000 pounds. The results are reported to be eminently satisfactory, the balls and bearings showing no appreciable wear, and the car being ready for service without any repairs after the long trip.

NEW POLISHING ROOM OF THE BROWN & SHARPE MANUFACTURING CO.

Visitors at the plant of the Brown & Sharpe Mfg. Co., Providence, R. I., before the "new building" (building No. 4) was erected, have often been shown the grinding and polishing room in the basement of the main or No. 1 building. This, we think, was always considered a model of neatness and much superior in its appointments to the general grinding rooms. Since the erection of the new building, however, a new room has been equipped on the upper floor which is much superior to the old room and much more comfortable and convenient for the workmen. It is the lightest and cleanest polishing room we have ever seen, which fact will be appreciated by examining the accompanying illustration, Fig. 1.

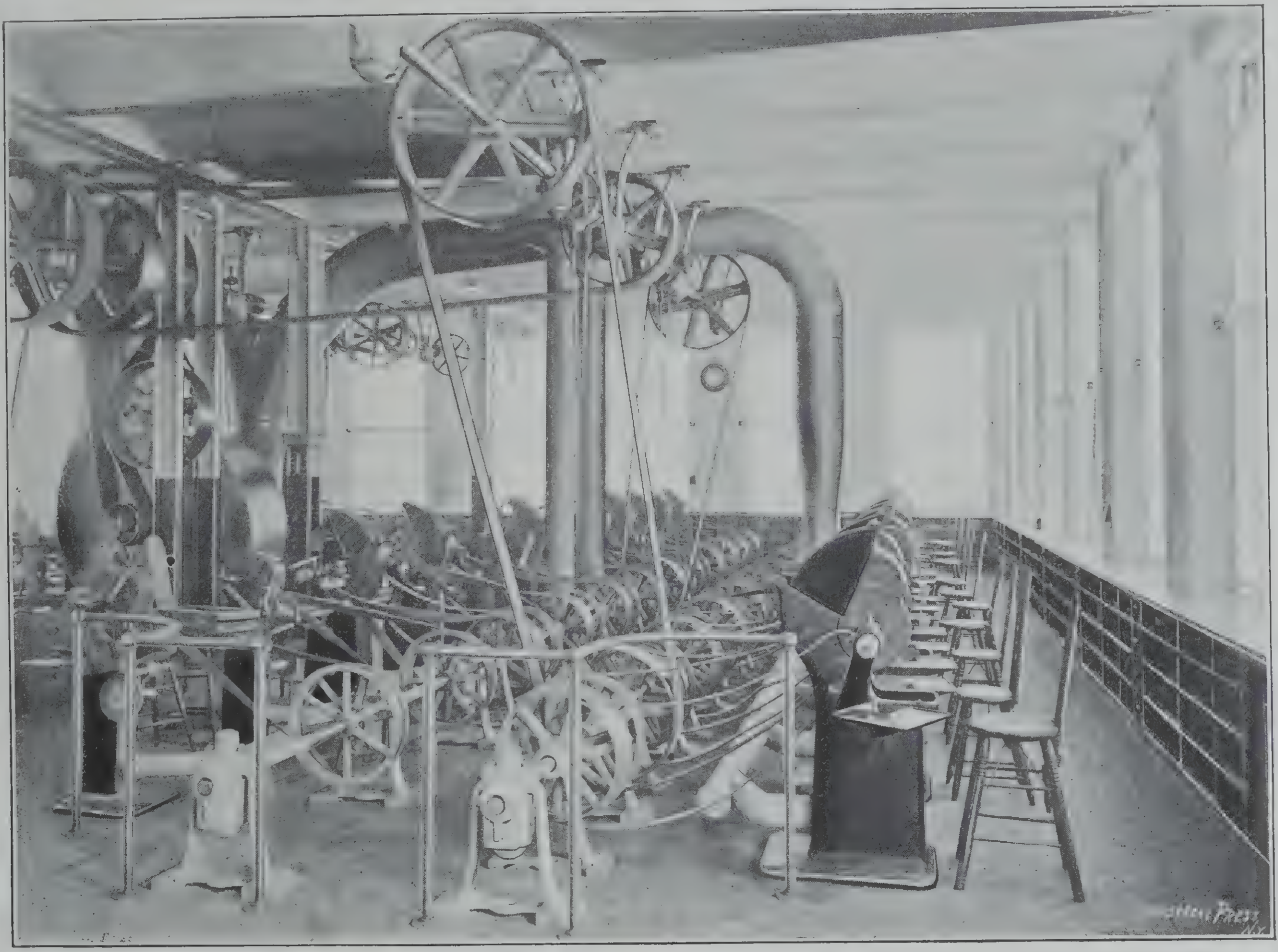


Fig. 1. New Polishing Rooms of the Brown & Sharpe Mfg. Co.

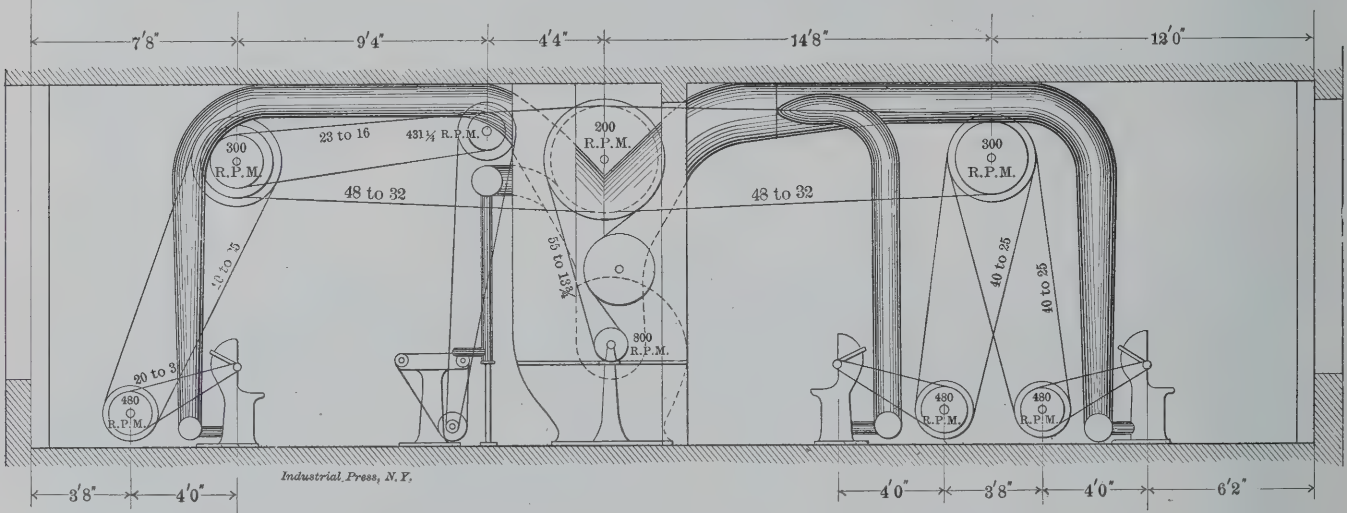
The piping and general arrangement of the machines and shafting are indicated in Fig. 2. The polishing machines are of the same design as those illustrated in the Brown & Sharpe catalogues some years ago, but which they do not now manufacture except for their own use, the machines now being handled by the Builders Iron Foundry, Providence.

The larger polishing machines shown in the foreground of the half-tone were especially designed with a view to economizing as much space as practicable. Ordinarily two machines are required, one running with an open belt and one with a cross belt, to enable the top of the wheel in one case, and the bottom in the other, to be used for polishing. In the machine mentioned, however, the horns for carrying the wheel spindle are located a sufficient distance apart to enable the spindle to be reversed. Each machine is provided with two sets of tight and loose pulleys, one set on each side, that carry open and cross belts, thus enabling the operator to use the same machine for polishing different classes of work that may require the use of the top or bottom of the wheel. The belt not in use is hung upon a hook provided for that purpose.

By this arrangement one machine answers for all kinds of work within its capacity, and does away with the necessity of the operator moving from one machine to another, thus keeping his work always in one place, and economizing, because practically only half as many machines are required as ordinarily.

Another important feature is that the loose pulleys are not mounted upon the driving shaft but upon especially arranged bearings that are either upon an extension of the shaft bearing concentric with the shaft or (where the bearing does not come into proper position) upon especially arranged supports. It is obvious that this arrangement reduces the wear of the pulley bearings to a great extent, as they remain stationary and do not revolve upon the shaft. The machine columns are hollow and have hoods partially encasing the wheels, while the bases of the columns connect with exhaust piping leading to the large fan shown at the center in Fig. 2. The draft from the rapidly revolving wheels forces the dust around under the hoods where it drops to the bottom of the column and is then taken care of by the exhaust piping and fan exhauster. The dust is delivered by the fan to a separator on the roof, which finally discharges to a can or dust collector enclosed within a closet on the floor of the polishing room.

The separator and collector are of the well-known cyclone type. There are now 36 buffing wheels of the type described, in the room, the smaller ones being shown in the illustration, besides several belting machines which also have dust guards. Ample provision is made for wheel storage around the sides of the room and the equipment includes washing machine, sink, glue stove, an emery chest divided into compartments, etc. The exhaust pipes are made in sections of different diameters, starting at 4 inches at the extreme end of each row of smaller polishers and at 5 inches at the ends of the row of larger machines; increasing to 10 and 12 inches, respectively at the center. It will be noted that a binder pulley is used for the belt driving the fan—a system quite generally followed throughout the works. The speeds of the different lines of shafting are indicated in Fig. 2.



Industrial Press, N.Y.

Fig. 2. Elevation of the Piping and General Arrangement of Machines and Shafting, Brown & Sharpe Polishing Room.

* * *

Thomas C. Lace proposes that a color scale be adopted by the National Blacksmiths' Association for forging, hardening, tempering, and annealing carbon tool steel which for tempering shall consist of ten pieces of tool steel of convenient size, tempered from light straw down to the greenish blue of the color when the temper has run out. Nine of these pieces should be divided into three divisions, the first three for shades of straw color to brown, the next purple to blue, and the third, blue. He says that the lithographic color scales in existence are generally a bad imitation of tempering colors. The scale referred to would be a *fac simile* of what would be required for the guidance of the smith in every particular. The printed scales lack the metallic luster of tempered steel and there is no pigment known that will imitate it exactly. The forging, hardening and annealing heats could be imitated to a certain extent by paint or colored glass, but either is subject to the same fault of the printed tempering scale, that is, the translucent color of hot steel, is lacking.

PISTONS AND PACKING RINGS.—2.

SOME DEVICES FOR FLOATING THE PISTON ON STEAM PRESSURE—EFFECTS OF WEAR.

J. H. Dunbar.

Since writing the first article under this heading (July, 1902 issue), I have secured copies of several patents, showing plans for floating the pistons of horizontal engines on steam, instead of letting them ride on the bottom of the cylinder. There is no question but that a practical scheme to support the pistons is needed, nor that it will not be welcomed alike by engine builders and engine users. Just now the tail-rod is growing in popularity, but it is objectionable, owing to its taking up room and adding to the weight of the reciprocating parts, etc. These and other faults make it so far from being satisfactory, that there is plenty of room for something else, if the device is practical.

Before discussing these patented inventions, to be referred to later, it is well to remember that pistons are not steam-tight, in the sense of a safety valve. If there are such, the writer has not seen them. There are plenty of pistons, which if the cylinder head is taken off, and steam admitted behind the piston, will not immediately begin to leak, but after the pressure has been on, say five minutes, a little lake of water will be formed on the bottom of the cylinder, and as soon as the piston and cylinder get hot, steam will begin to sizzle around the piston at some part of its circumference. The actual leakage, when the engine is running, will be much more than when standing with the pressure on, for the friction of a film of water between metal surfaces is greater than that of a gas, between like surfaces. When the engine is standing with the pressure on, most of the leakage changes to water, owing to the thin space, and comparatively cold surfaces between which it must pass, while if the engine was running, it would to a greater extent, be steam. As illustrating the difference in leakage, between water and a gas, take a gas engine, turn it on the compression stroke to the center, or rather to the end of its stroke, and if the compression does not all leak out in less than thirty seconds, the piston is tighter than any that the writer has met with. Gas engines, as a rule, are very easy to turn, when the lead is off, and if the fly-wheel is "tramped" around leisurely, but very little resistance will be encountered, on account of compression. I think that for tightness, gas engine pistons will compare favorably with those made for any general purpose. If any engineer thinks his valves and piston absolutely tight, let him take a gasfitters' test pump and try to jam the cylinder full of wind, through the indicator pipe. Or let him clean the indicator piston and cylinder, then connect the indicator to a hand bicycle pump, and see how much pressure he can churn up against a hundred and twenty pound spring on the piston, using air as a pressure-producing medium. Then turn the indicator upside down fill the cylinder full of oil or water, then pump in air, and note the difference. Of course, in this, as in everything else, different experimenters will get widely differing results. There is one thing, however that they will all agree on, viz: That the volume of leakage, under like conditions, is much greater with a gas than when a liquid is employed to produce motion in a machine, by pressure, or when acted upon by a machine to produce pressure. It is not much trouble to accurately determine the air leakage of a piston but it is different when it comes to steam. The writer knows of no satisfactory method of measuring the steam leakage of a piston when it is in service. Pistons that apparently leak only a little steam, do so enormously when used against air.

The first patent that the reader's attention is called to, in which the inventor's object was to make the piston swim in the cylinder, is shown, substantially as in the patent, in Fig. 1, of the piston. The packing rings are set obliquely in the head, are loose in the groove and so shaped as to act as check valves, i. e., when ring *A* is forced to the side of its groove marked *B*, steam can flow under and around it to the space between the rings, but not past ring *C*. On the return stroke, the rings change to the opposite sides of their grooves, and steam enters the space past packing ring check valve *C*. It will be noticed that there is more area on the bottom of the piston, between the rings, than on top, hence its tendency to lift when steam is admitted to it. The trouble and expense to make pistons and rings by this method, and the serious question as to whether the rings would act according to the inventor's dictation, will stand between the invention and its popular use. Better results would no doubt be had, if the piston was run bottom side up, and as much steam as possible be kept from between the packing rings. The patentee is Mr. William J. Thomas, Sausalito, California.

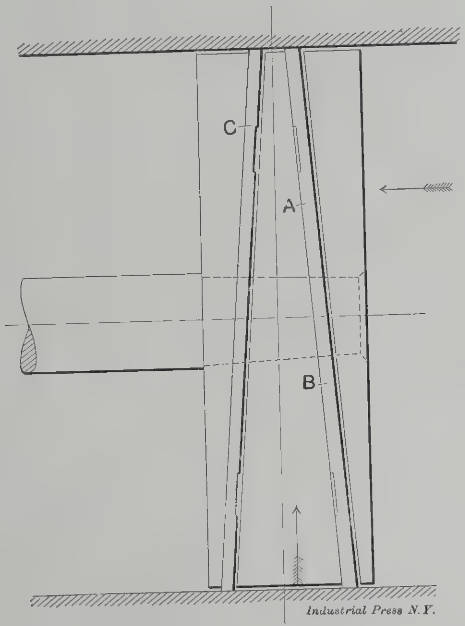


Fig. 1. Packing Rings set Obliquely to "Float" the Piston.

Mr. Henry M. Hunt, Indianapolis, Ind., has patented an invention for counterbalancing the weight of the piston and rod of horizontal engines, by making the bull-ring with a cavity in the bottom and surrounding it with packing strips, and then keeping a constant pressure there, just sufficient to lift the piston. To do this he has a pressure-regulating device, inside of the piston, consisting of three helical springs, three valves and a diaphragm, with joints and ports to correspond. To make Mr. Hunt's invention more easily understood, and also to provide some means by which the steam may get on top of the bull-ring, and go down through it to the top of the diaphragm I have made several changes in his design.

Fig. 2 shows this invention. The cavity in the bull-ring is *t*, and *s* is the diaphragm, connected by toggle joint to the ball valves. This view shows the port holes *a* through the followers closed. When the pressure in *t* gets too low, the diaphragm drops and opens one of the ports, and steam flows in from the steam side of the piston, the hole in the opposite follower being closed. I show holes drilled through the bull-ring, near the top, marked *c*, in order to allow any steam that may get between the rings, to press the diaphragm down, and maintain a pressure in the cavity sufficient to carry the weight of the piston, and also the steam load on top of it. I do not see why, for horizontal stationary engines, an arrangement of this kind could not be made to just float a piston. On locomotives such pistons would do a lot of vertical hammering if they had any play at all in that direction. In general, they will likely be regarded as costly, unreliable and not adapted to piston heads made in one piece, the latter being the most important consideration.

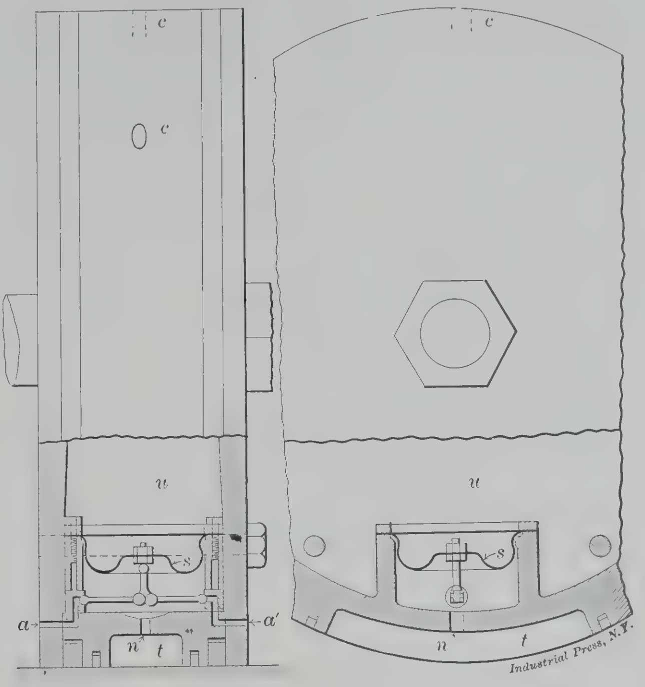


Fig. 2. Another Device for "Floating" a Steam Engine Piston.

In Fig. 3 we have what the inventor, Mr. James Thierry, Laramie, Wyoming, calls a "self-poising" piston. I have taken some liberty with this design too, by putting the counterbalancing cavities on the bottom of the piston, instead of on top where they are shown in the patent. I think that this inventor has made some mistake in his design, for with the cavities on top of the piston, there don't seem to be anything for the steam to do but to help hold the piston down. There are several patents, similar to this one as I have shown it, and all of them would be improved by some kind of a compensating device that would take care of the steam load and varying steam pressure on the piston.

As a parting shot at this part of the subject, I suggest making a piston as shown in Figs. 4, 5, 6 and 7. Fig. 4 shows an end view of it in section at the face of the rings. Fig. 5 is a vertical section through the center of the piston. Fig. 6 is an enlarged plan view of the joint, or cut in the outside ring *a*, and shows how the inside ring, *b*, stops any leak that would otherwise take place there, by the steam going in at one end of the lap, down under the ring and out at the other end. The flanges of the piston do not touch the cylinder at any part of their circumference, and are turned semi-eccentric, so that as the ring *a* wears down they will still clear the cylinder; for it is intended to make the piston a steel casting of one piece, it being understood that steel and cast-iron do not wear well together, hence the flanges are relieved on the bottom. The outside ring, *a*, is cast iron, and made eccentric, and its thick side put at the bottom so the flanges can be cut away, and still leave about the same depth of bearing on the edge of the ring at all parts of its circumference. Ring *b* is made eccentric to give it a uniform groove contact.

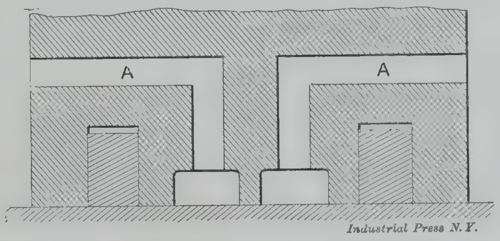


Fig. 3. Thierry's "Self-poising" Steam Engine Piston.

Its thick side is up, and both rings are dowelled in their respective positions by pin *c* in the piston.

To equalize, or rather to get an average pressure between the ring and cylinder on all parts of their circumference, the bottom half of ring *a* is reduced in breadth an equal amount on each side as shown at *xx*, and in depth an amount equal to the eccentricity of the ring. The amount of side reduction depends on the weight of the piston, and the average steam pressure upon it. If the head weighs 500 pounds, is 20 inches in diameter and the pressure 100 pounds, then the width of the ring should be reduced on each side; would be $500 \div 100 \times 20 = \frac{1}{4}$-inch, making a 20-inch ring 2 inches wide. on top, and the bottom half 1½ inch wide. Now the steam pressure on the outside of the ring where it has been cut away at *xx*, tends to collapse it, and not to lift the piston bodily. The tendency to collapse the ring under such circumstances would be about as great as though the ring traveled over the counterbore ¼ inch. Were it not that some steam gets under the rings to hold them out to the cylinder, it would not do to let them travel past the counterbore, as is generally done. Suppose with our 20-inch piston, the pressure at the beginning of the stroke is 200 inches, then its tendency to collapse the ring vertically is $\frac{1}{4} \times 20 \times 200 = 1{,}000$ pounds, but if there is four times the area on the inside of the ring, and one-fourth the pressure, the collapsing tendency is just balanced, but the total pressure between the ring and cylinder is 500 pounds more on the top half than on the bottom, and consequently, the top half of the ring and cylinder will be worn the most. Suppose further, that the engine takes steam full stroke, and that the 200 pounds are maintained and also that the wear is proportional to the load, making the top half of the ring wear twice as much as the bottom, say ¼-inch and ⅛-inch respectively. The piston, as a whole, has gone down just as much as the bottom of the ring and cylinder, has worn, but never had a tendency to lift, nor can it unless the ring collapses.

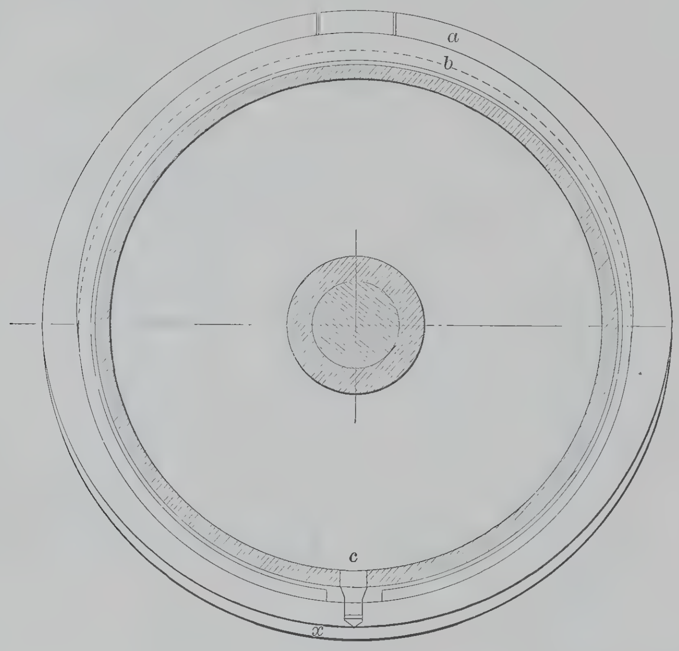


Fig. 4.

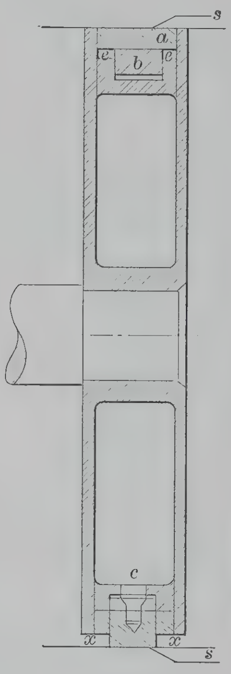
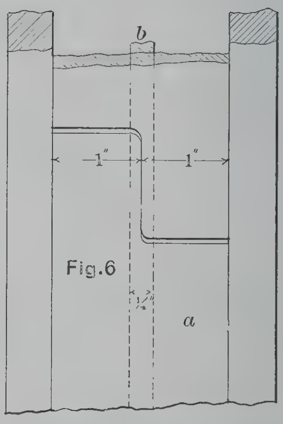
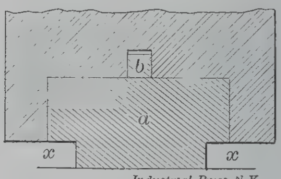


Fig. 5.





Industrial Press N.Y.

Fig. 7.

I feel safe in saying that unless a ring is so tight in its groove that it is liable to stick, more steam will get under it than is necessary to prevent collapsing. Of course, rings can be run so far over the counterbore that the external pressure might exceed the internal pressure, but there is no necessity for it. A 1-16-inch over-travel is enough, and in general there does not seem to be any use for more. The dotted lines *ss*, in Fig. 5, represent the counterbore, and show the proportionate distance the rings should travel over it.

Ring *b* in addition to covering the joint in *a*, confines to a great extent, the steam to one end of ring *a*, holding it in space *e*, thereby lessening ring and cylinder wear, and consequent friction. Its width (ring *b*) will depend on circumstances, but as a rule one-half the breadth of *a* will be best. It is shown in Fig. 5 so wide that possibly not enough steam will get under it from space *e* to keep both rings from collapsing. In Fig. 6 it is only wide enough to cover the cut in *a*, which of course limits its breadth in that direction.

It seems, too, that the weight of a 20-inch piston, say 500 pounds, having a bull-ring surface of 2½ inches wide and 15 inches chord length, in contact with the bottom of the cylinder, ought not to cause any appreciable wear, due to its weight only; for when spread out, it is less than 14 pounds to the square inch, certainly not enough to pay to put on a tail-rod. If however, in addition it has to carry a steam load on one flange, and whatever may get on top of the bull-ring, it is different. If the flanges and bull-ring are cut away so that they are balanced, so far as steam pressure is concerned, then a tail-rod may be of some use, provided it is stiff enough to carry the piston without too much deflection. If the flanges and bull-ring are not relieved, the bottom of the cylinder is worn to a circle, whose radius is determined by the amount the piston and tail-rod will deflect. Without a tail-rod, it does not make much difference to the piston if the crosshead does lift a little at each end of the stroke, as a locomotive does in running ahead, but if a tail-rod is used the piston gets an unnecessary amount of shaking up and down.

Near the close of the first article on this subject, I implied that one ring to the piston was enough, and so far as ring and cylinder wear is concerned, the piston I have shown in Figs. 5 to 7 may be called a single-ring piston. There are some advantages that a piston of this type has over those with a ring at each end of the piston as shown in Fig. 8. To make it clear, the "deformity" has been somewhat overdrawn, for stationary practice, but locomotive men will recognize it as "true to life." In the sketch, the flanges are reduced in diameter so the weight of the piston is borne by the bull-ring, the packing rings having a liberal amount of vertical play in their grooves. It is evident that if one ring wears the cylinder any at all, one more will wear it a like amount, and the bull-ring will probably wear the bottom of the cylinder as much as both packing rings. So it is easy to see that that part of the cylinder which is traversed by all the rings, must suffer more wear than at the ends of the stroke, where only one of the end, or outside rings touches it, making the shoulders as shown at each end of the cylinder. If wear is proportional to pressure, and only one ring at a time has pressure under it, a single ring would wear the cylinder as much as both those in Fig. 8. But that is questionable, and in the high-pressure cylinders of multiple-expansion engines, there is pressure on each side of the pistons, but the most unnecessary wear in two-ring pistons would be due to a trifling leak of one ring that would let enough steam through and get under the other. There is often but a few cubic inches of space between the rings in pistons, and when that gets full of water, an insignificant amount of leakage from the live steam side of the head may keep the pressure between the rings, equal to that on the piston. It was shown in the first part of this article that steam may leak considerably, where water will not, hence if this theory holds good, an objectionably high pressure will be constantly between and under the rings. It seems clear to me that the better the rings fit in a two-ring piston, the more pressure will be maintained under them, and the more wear and consequent friction will be produced. If both rings leak plentifully, the pressure under each of them will be less. Water has no trouble in getting out if the hole is big enough.

It will occur to the reader that the wider a packing ring is, after some economical width is exceeded, the greater frictional resistance it will produce. Were it not for the steam pressure that gets under it, making the load to carry proportional to its area, the width of rings would be in the same class as journals, crossheads and other bearings. As it is, ¾-inch is believed to be as good a breadth as any, for diameters of 20 inches and over. Under that diameter, ½-inch, ⅜-inch, ¼-inch, etc., will be found to be satisfactory. Rings should always be made wide enough so the piston will strike the cylinder heads, before the rings can get into the counterbore. For a single-ring piston, where the weight of the head is carried on the ring, it ought of course be made wider than the regular two-inch width. For the piston shown in Fig. 5, ring *a* should be 1 inch wide at the bottom, 1½ inch wide at the top, and ring *b* ½-inch wide, and edges parallel. Steam will of course get under the outside ring at the cut, if at no other place, and probably under the inside one too, but there will be no pressure higher than that of the exhaust in space *e* on that side, for any pressure that gets in from the live steam side can get out easily by the same route when the exhaust takes place. Taking the weight of the piston into consideration, this combination of ring widths, would wear a cylinder about as much as one ¾-inch ring in a piston of like diameter supported on a tail-rod. It will be noted that the flanges of the head in Fig. 5 are considerably smaller than the cylinder, and that the pressure on the edge of the ring will keep it against the exhaust. The rings ought, of course, to be as close a fit in their grooves as practical, and also have smooth, accurate surfaces. Then the only time they will have an excuse for leaking will be when they are shifting in the grooves, which they will do when the pressure is about equal on both sides of the piston. If there is any difference in the amount of play, the outside one should have the most, to make sure that the edges of the inside ring make joints in its grooves. As regards leakage, the edges of ring *a* are not important, but its circumferential surfaces are.

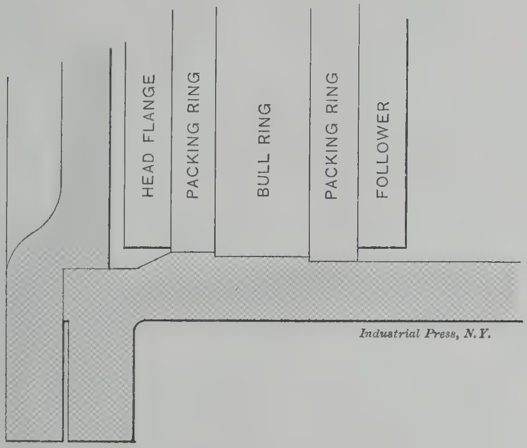


Fig. 8. Showing the "Step" Effect of Packing Ring Wear.

The question of lubrication is always closely allied to any moving part of a machine, and while there are other parts of an engine that may be of more importance, there are none that are oiled in such a bungling manner. It is stationary practice to turn a drop of cylinder oil loose in five or six barrels of steam, somewhere between the boiler and the engine, and then it is a case of "go as you please" until it is filtered out of the exhaust, when it is cooked over again. When the supply is liberal, as it usually is, enough of the oil finds the parts to be lubricated, and excessive wear is seldom found. When it comes to lubricating locomotive cylinders it is different. There they allow a drop of oil to every few miles the engine runs, or a few drops to the round trip, I have forgotten which. The oil and steam are mixed the same way as in stationary engines, but the homeopathic doses of oil administered to the steam used in the locomotive, are too often rushed through to the smokestack, without having time to get sidetracked on the cylinder. Now if there is any law of friction that is not befrilled and festooned with strings, it is the one that wear and frictional resistance are greater between dry, than between lubricated surfaces. I believe that this law is as true as it is that two trains cannot pass on a single track, and yet some railway managers offer their engineers a premium on the oil that they save. This puts me in mind of a picture the Jones & Lamson people have in their catalogue, of an old party with a microscope, looking for a leak in the head of a barrel, while the bung-hole at the bottom is wide open.

* * *

THE VALUABLE MAN OF THE FUTURE.

In a handbook recently issued by the New England Association of Teachers of Metal Work, containing addresses given before that association, in a paper on Hand Work in Modern Shop Practice, by our contributor, Mr. Edward R. Markham. He comments on the modern tendency to manufacture as cheaply as possible by means of machinery, and to abolish hand work, and closes with a bit of personal reminiscence. He says:

> Young men learning the trade are not, as a rule, taught to become skilled filers, or scrapers, and less is taught them about the use of the cold chisel and hammer. Any work of this nature is left to the "old fogies" who are considered oftentimes as being good for nothing else.
>
> In time these older men will have finished their shop work, and as machines are built that require in some of their details very accurate hand work, who is to do it? Not the average young journeyman, or the apprentice learning his trade in most of our machine shops. There are exceptions to the conditions I have cited; there are employers who realize the conditions that must face them in a few years, and are educating their young men in lines that will allow them to fill that gap that must come. But these employers are the exception rather than the rule. I predict that in less than twenty years the machinist or tool maker capable of doing good hand work will be at a premium. He will not have to depend on any organization to keep up the standard of wages for him. He will be able to demand any reasonable compensation. The law of supply and demand will attend to his case.
>
> I learned my trade under my father. He is one who believes in teaching a boy as *much* of a trade as possible. Many days, weeks and months have I stood at the vise with file or hammer and chisel in my hands, and worked and growled because I was made to do things that boys in other shops knew nothing about. But many, many times have I been thankful that my father knew more than I thought he did.
>
> There have been times when I doubted the advantage of having been able to command the confidence of the boss to the extent that he would trust me to go down into the wheel pit, and, with chisel and hammer as weapons, and a tallow candle for my light, chip a keyway in a jack shaft; or, tell me if he would like to have me stay a little while in the evening and cut another in the main line. It isn't all fun, sitting straddle a line of shafting and chipping a slot one-half inch wide and six or eight inches long, especially when you haven't room to swing the hammer, and must give the force of the blow by main strength rather than by the haft of the hammer head. But it had to be done and the man that can do the unusual things about the shop is the valuable man.

* * *

Rock blasting extraordinary has recently been done in Wales. One blast in the Trever quarries, Carnarvon, brought down 60,000 tons of rock, and 12,500 pounds of powder were exploded. The other blast was still larger, it being estimated that 100,000 tons of rock were dislodged. This blast was made to secure material for the building of a breakwater at Goodwick, Pembrokeshire. Only 10,500 pounds of powder were fired, yet the amount of rock is greater than in the other case, probably being the largest ever brought down by one blast.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY
Design—Construction—Operation.
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
9-15 MURRAY STREET, NEW YORK CITY.
CHICAGO—1462 MONADNOCK BLOCK. BOSTON—620 ATLANTIC AVE.
PHILADELPHIA—MACHINERY FLOOR, THE BOURSE.

SUBSCRIPTIONS.
SHOP EDITION, $1.00 A YEAR. TEN CENTS A COPY.
ENGINEERING EDITION, $2.00 A YEAR. TWENTY CENTS A COPY.
FOREIGN EDITION, $3.00 A YEAR PREPAID.

LESTER G. FRENCH, Editor.
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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

DECEMBER 1902.

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The entire Engineering Edition is printed on coated paper, and a data sheet is furnished with every copy—price $2.00 a year. The Shop Edition is printed on super-calendered paper—price $1.00 a year.

Election day has come and gone and the usefulness of the voting machine has again been demonstrated in no uncertain manner. The first voting machine tried in New Jersey was used in Paterson the last election and with very gratifying results. The result was known ten minutes after the polls closed. In other districts the poll clerks worked hours, in some cases until five o'clock the next morning before the last ballot was counted. The voting machine is the one "machine" in politics that all good citizens may unhesitatingly indorse. It saves time in voting and counting, and insures the secrecy of the ballot. The cost of paper and printing for tickets used and unused in every election, is alone an item of considerable importance. The voting machine has come to stay.

* * *

GRAPHITE VS. FRICTION.

We have occasionally had inquiries about the use of graphite as a lubricant and points have been brought out through correspondence that may be of interest to the general reader. The action of graphite is somewhat different from that of fluid lubricants and there are differences of opinions as to the part it is capable of playing in alleviating friction, some contending that graphite is not properly called a lubricant, and even that it has abrasive properties, unfitting it for use between bearing surfaces. This latter opinion was recently expressed to us by a person who had been engaged in testing lubricants, but who, possibly, may have been somewhat prejudiced in the matter.

According to the strict definition of the term, graphite is rightly called a lubricant. The term is derived from the Latin *lubrico*, meaning to make slippery, a result certainly accomplished by graphite. While we have not had opportunity to verify the statement that graphite has abrasive qualities, it is very evident that the results from this action are so slight as to be negligible in practical work. We are inclined to the opinion that, if abrasion has actually been observed, it is due to the presence of foreign substances rather than to the graphite itself.

The crystalline, or more commonly called flake graphite, is the kind most suitable for bearings. It is composed of flakes of irregular circular shape, about 1-40 inch in diameter and varying from .002 to perhaps .0002 inch in thickness. The formation is very similar to that found on a large scale in slate quarries, where the slate breaks up readily into thin slabs, entirely similar to the minute flakes into which graphite separates.

The function of graphite is not so much to take the place of lubricating oil or grease as to make the surfaces of the wearing parts smooth and polished so they will slide over one another with as little friction as possible. For this reason it is perhaps misleading to call graphite a lubricant. The result accomplished by it is analogous to the result obtained by the use of the modern grinding machine when finishing journals or bearings. If the journal of a rotating piece is finished by turning or filing, simply, and is soft, it will take more power to rotate it in its bearings than if the parts are hardened and ground, and accurately cylindrical. Friction is caused by the slight irregularities of surfaces fitting into one another, and so requiring force to make one slide upon the other. Grinding reduces these irregularities and when we come to a surface as smooth as ice the friction is very little indeed. Graphite accomplishes practically this result. It fills up the pores and produces a smooth surface, in just the right condition for a bearing, and as the coefficient of friction of graphite is only about half that for iron or steel, its value in a bearing is very manifest.

While graphite is seldom used as a lubricant without oil, its low coefficient of friction makes it a fairly efficient lubricant when employed without oil, or when for any reason the oil has become dissipated, leaving a graphite coating on the wearing surfaces. Such a condition might exist in a gas engine or superheated steam engine cylinder, or a heated bearing, if the temperatures were high enough to vaporize the oil. It is well known that graphite will "cool off" a hot bearing, for the reason, of course, that it makes smooth surfaces out of the roughed-up ones; and in a similar way, and on the plan that prevention is better than cure, its previous use will tend to prevent a bearing from roughing up and heating. It is more effective on rough than on hardened and ground surfaces and is generally considered very efficient for heavy work, where it is not liable to be squeezed out from between the surfaces by the great pressure. But there are cases where it is decidedly better for light work than oil; for example, in the runways in the Mergenthaler linotype machines. In these the matrices from which the letters are cast are of brass or composition, and upon the depression of the keys on the keyboard they slide down inclined grooves to their proper positions for the casting of the line of type. Were oil used to lubricate the grooves, it would gather dust and the matrices would stick, a difficulty not experienced with graphite.

Graphite is almost indestructible. It is pure carbon and is not attacked by acids and will protect metallic surfaces from corrosion. It is used by many machinists when putting together machinery that must be exposed to the weather, such as locomotives or hoisting machinery. In these cases, if the screw threads and surfaces in contact be coated with a film of graphite and oil, the parts will not rust together and can be easily taken apart when occasion requires. In steam and gas engine cylinders graphite is not as generally employed as would be the case if it were easier to automatically feed it into the cylinders, as is done with oil by the use of the sight-feed lubricator. Many devices have been invented for the purpose, however, and some of them are proving quite successful.

Graphite is efficient in reducing friction and its use is increasing as its merits become better known and the way in which it operates is better understood. No more striking illustration of its qualities can be given than by mentioning a peculiar incident related by Mr. Malcolm McNaughton, of the Joseph Dixon Crucible Co. In India, where graphite is mined, many houses have tiled roofs. These are of the simplest kind, having no locking devices for holding the tiles, which are laid loosely on the roofs. The angle of the roofs is less than the angle of repose for the tiles. The winds carry the dust from the plumbago compounds and drive it into the crevices of the roofs; and in some cases the angle of the roofs has proved too great under these conditions and the tiles have slid to the ground, whereas, were it not for the graphite they might have remained on the roofs for years.

THE ROTARY PUMP.

The first steam engine was undoubtedly of the rotary reaction type, but the first practical steam engine was of the reciprocating piston type, converting rectilinear motion into rotary motion by means of the connecting-rod and crank. Now the signs of the times seem to point to the displacement of the reciprocating piston steam engine by the steam turbine, and who would dare to assert that the same fate may not befall the present type of gas engine? There seems to be no theoretical reason why the gas turbine cannot be brought to a successful issue although the practical difficulties appear at present to be formidable enough. In the matter of pumping, the reciprocating piston pump has held the field, both for moving liquids and gases. It is true that we have had the centrifugal pump for liquids and the fan blower for gases, but until comparatively recently these have been regarded as being strictly limited to low heads and light pressures. But there is no good reason for such a condition except the difficulty of getting the proper designs. All good rules work both ways, and the reversible cycle is a well-established principle of mechanics as well as of thermodynamics. The water turbine utilizes the energy of water falling from great heights and does so with good efficiency. Why should it not in reverse order act as a pump working against high heads? Again in the case of the fan blower: If a pressure of a few ounces per square inch may be readily obtained with an ordinary fan, two blowers connected tandem fashion should double the pressure of delivery, three triple it, and so on.

A paper was recently read on rotative pumping by Mr. John Richards before the Technical Society of the Pacific Coast, in which it was pointed out that the engineering world has recently entered on an anti-reciprocating machinery epoch and that pumps as well as steam engines would eventually be re-formed on these lines. The first centrifugal pump is believed to have been invented about two hundred years ago by a Frenchman, Denis Papin, in Hesse, Germany, where it was known as the "Hessian suck." Centrifugal pumps are cheaply manufactured and work very well where the heads are low, but as ordinarily constructed they are not adapted to high heads, say more than forty feet, as the vanes encounter frictional resistance that seriously reduces the efficiency. The kinetic energy of water leaving the vanes of a centrifugal pump cannot be efficiently converted into pressure without using water spaces, as is done in the Sulzer high-lift centrifugal pumps. The ordinary centrifugal pump, may, however, be compounded for higher heads. The first attempt made in England in this direction was that of Prof. Osborne Reynolds, who designed a triple compound centrifugal pump which worked efficiently, but it was not a commercial success. One great difficulty met in centrifugal pumps is getting a motor adapted to the pump, the tendency always being to adapt the pump to the motor. Prof. Unwin says that the friction of vanes increases as the fifth power of the diameter; so there must be a great waste of power when the wheel is made too large, in the effort to accommodate it to the motor.

The centrifugal pumps made by Sulzer Bros., Mannheim, Germany, are remarkably efficient and in consequence have acquired a world-wide celebrity. The following table is made up of the actual results obtained from four Sulzer pumps:

Gallons raised per minute ..	285	444	634	870	1,400	2,060	3,170	4,120	5,706
Head in feet, one-stage	78	111	164	246	262	262	262	262	262
Head in feet, two-stage.....	157	223	328	492	524	524	524	524	524
Head in feet, four-stage....	315	446	656	984	1,050	1,050	1,050	1,050	1,050
Efficiency, per cent	67	70	72	74	75	76	76.5	77	77.6

An installation of Sulzer pumps is working in the Horcajo mines in Spain against a head of 1,550 feet (672 pounds per square inch) and at an efficiency of 70 per cent. The operation of rotary mine pumps from one level to another is eminently the field of the electric motor. Great masses of pump rods and moving machinery are replaced by apparatus that can be conveniently located and connected by insulated wires, the whole making a combination not easily excelled in the matters of simplicity and elasticity. A cut is given in the paper illustrating the construction of a four-stage Sulzer pump to operate against a head of 800 feet or 347 pounds per square inch. The construction shown does not, however, represent their present practice.

The De Laval Steam Turbine Co. are using rotary pumps successfully against high heads. In their machine the turbine shaft makes several thousand revolutions per minute, say, perhaps 30,000, while the driving shaft which is geared to it rotates much slower, say, at 1,500 revolutions. They use two pumps, one for suction and one for forcing. The suction pump is placed on the low-speed shaft, and the forcing pump on the high-speed shaft, with the result that the water obtains so high a kinetic energy that it easily discharges against a head of 250 pounds or even more.

In regard to rotative compression of gases Mr. Charles Parsons has furnished fans driven by steam turbines that deliver air under a pressure of 25 pounds per square inch in what is believed to be a one-stage machine. A two-stage machine on the same principle would double the pressure, and so on. From experiments recently made it is believed to be quite practical to compress gases to high pressures by the direct-acting rotary process, and we may before long look for some interesting developments along these lines.

* * *

LIQUID FUEL FOR THE UNITED STATES NAVY.

In the November issue appeared an editorial of some length on the possibilities of liquid fuel, which gave some of the recent developments in the use of petroleum fuel as applied to stationary, locomotive and marine engineering. As mentioned in the editorial the United States Navy Department have been making quite extensive experiments with liquid fuel with the view of using it to a greater or less extent on naval vessels. As might be expected these tests are of an exhaustive nature and broad in their scope, the object being to find the best form of apparatus, how well it is adapted to naval use, and the nature of the practical difficulties to be overcome. Rear-Admiral Melville's report to the Secretary of the Navy has now been made public, but of course it is not conclusive on all points, the findings of the board published being of a preliminary nature. The report indicates, however, that the use of liquid fuel for military purposes is desirable, but that there are a number of practical problems yet to be solved before it can be regarded as being fully adapted to such use.

As regards the matters of cost and supply of petroleum, it is pointed out that the cost will always be greater than that of coal except where unusual conditions prevail. The expense of transportation alone will be sufficient to make oil cost more than coal except perhaps at some Gulf and California ports; and while the matter of cost is secondary in military matters, it must be considered. As to the limited supply of petroleum, it is mentioned that probably not more than one per cent. of the total amount of oil used as fuel would be consumed by the navy.

The installation of fuel oil apparatus on board ship is fraught with many difficulties. Great care must be taken to prevent fires and explosions. Not only must sparks from the furnaces be guarded against, but also the dangers arising from the electric wires and apparatus. It is thought probable that the great bulk of such fuel used on warships will be stored in the double bottoms. But wherever stored there is the difficulty of preventing the accumulation of explosive gases in tanks that are partially full. In the merchant service the oil is often stored in expansion tanks or trunks that rise to the height of the deck. On some of these vessels the oil tanks are surrounded by a cofferdam so that any leakage of oil will be quickly discovered. It is said to be comparatively easy to free such tanks from the dangerous gases that tend to accumulate therein.

The special board composed of Lieutenant-Commanders Edwards, Parks and Bailey sought to determine: 1. The relative advantage of air and steam as an atomizing agent. Air compressors are not desirable on shipboard as they are heavy and take up considerable room. If steam is to be used instead it is important to know to what degree to superheat it in order to make it a satisfactory atomizing agent. The use of air making necessary an air compressor, is not a vital objection, however, since air compressors are already in use on shipboard for other purposes. 2. The pressures at which oil, steam and air should be delivered at the burners. 3.

The best design of steam boiler for liquid fuel. 4. The simplest and most economical method of heating the air and oil. 5. Whether or not an air receiver is necessary between the compressor and the burner to reduce the air pulsations. 6. The relative value of the leading types of oil burners. The Bureau have over 2,000 drawings and specifications on file and about 30 patents are being issued a week on oil-burning apparatus. 7. The non-production of smoke. This is most important from a military standpoint.

The board also sought to find: 1. The evaporative efficiency of oil as compared to coal under like conditions. 2. The degree to which combustion could be forced with both steam and air as the atomizing agents under forced and natural draft. 3. The ability of the oil burner to work under forced draft. 4. The liability of the boiler to injury under forced draft. 5. The amount of steam necessary for atomizing the oil. 6. The effect of pre-heating the air necessary for combustion. 7. The time required to properly train firemen to care for oil burners. 8. The best means of reducing the roar caused by the minute and incessant explosions within an oil-burning furnace.

With the Hayes oil burner it was not at any time found possible to get an evaporative efficiency (corrected) of 11 pounds of water per pound of oil. Steam was furnished from an independent boiler at a pressure of 90 pounds. The oil was fed to the burners at a pressure of 80 pounds. During the trials the pressure for atomizing purposes as well as the pressure at which the oil was forced to the burners, was increased each day. It was found that the higher the pressure the greater the amount of water evaporated. The efficiency was also slightly increased with the higher pressure, but the percentage of steam required for atomizing also slightly increased with the pressure. It was also found that the thermal efficiency of the oil burned was not increased by the use of steam. The popular idea that the steam is disassociated at the high firebox temperature and that the hydrogen and oxygen are afterwards united, is regarded as a misconception. All steam that enters the furnace will escape as steam and carry with it considerable waste heat. The amount of waste heat carried off in this manner will depend on the temperature of the furnace and the amount of steam introduced. The quantity of available heat for evaporative purposes is undoubtedly reduced by the use of steam as an atomizing agent. The information that has already been secured on the subject of liquid fuel and made public, is summarized as follows:

1. That oil can be burned in a very uniform manner. 2. That the evaporative efficiency of nearly every kind of oil per pound of combustible is probably the same. 3. That marine steam boilers can be forced to as high a degree with oil as with coal. 4. That the firemen favor oil. 5. That the air supply necessary for combustion should be heated before entering the furnace. 6. That the oil also should be heated. 7. That when using steam as the atomizing agent higher pressures are undoubtedly more efficient in atomizing the oil than low pressures. 8. That under forced draft conditions no means have yet been found for preventing the escape of black smoke from the funnels. This condition is very undesirable from a military point of view. 9. That the consumption of oil cannot be forced to so great an extent with steam as with compressed air as the atomizing agent. This is probably because the air for atomizing also supplies oxygen, while the steam displaces the air entering to support combustion, and thereby hinders it somewhat.

The boiler used in the experimental tests was of the Hohenstein straight water tube type. This boiler, in the opinion of the Board, is one that can be put on the very limited list of American straight tube boilers that have been found suitable for naval purposes. Careful examination of the boiler after the tests showed no distortion of the tubes nor any damage to it whatever, although it had been subjected to an unusually severe work. The tubes remained free of mud, showing a good circulation. Some recommendations were made which it was believed would improve it for naval purposes, one being the use of a 42-inch drum in front instead of a 24-inch drum. This would tend to make the water level more uniform in a seaway.

NOTES AND COMMENT.

REVIEW OF CURRENT EVENTS, TECHNICAL AND MECHANICAL.

When the Hudson River tunnel, track elevations and general abolishment of grade crossings, and other improvements now in progress on the Pennsylvania Railroad between New York and Philadelphia are completed, it is predicted by President Cassatt that the distance between the two terminals (more than 90 miles) will be made regularly by the through trains in one and one-half hour. The time will be correspondingly reduced, on account of similar extensive improvements, between New York and Baltimore, Washington and other points.

We have previously commented on the extensive use now being made of concrete construction in place of stone for all kinds of building purposes. Concrete is successfully used for foundations, retaining walls, culverts, arches, walls of buildings, chimneys, etc. A concrete dam is nearing completion near Ithaca, N. Y., which is being built to impound a water supply for that city. The dam is across a narrow gorge and will be 100 feet long and 90 feet high. The concrete wall will be 8 feet thick at the bottom and 2½ feet at the top. Expanded sheet steel plates are imbedded in the wall to bind together as one solid mass and to give the necessary tensile strength. The dam will be faced on both sides with vitrified brick.

A press dispatch to the *New York Times* says that after making a thorough test of oil as fuel on its passenger locomotives for ten months, the Southern Pacific Railroad has decided to return to the use of bituminous coal. Its mines at Carbonado recently received orders to begin shipping 25,000 tons a month to San Francisco. Those mines have been operated by the Southern Pacific for twenty years, but were partially shut down after the road began using oil. During that time the product of the mines has been used for coke making. It is reported that oil was not a success on the passenger locomotives for two reasons. One was that it deposited a coating on the flues, which had to be removed every day, otherwise it kept the heat from the water, causing a great waste of fuel. The other was that the intense heat produced by the oil also cracked and split the boiler sheets.

The following table taken from a paper on the world's coal supply, issued by the Treasury Bureau of Statistics, shows the coal production of the world in the latest available year, the figures for the United States, United Kingdom, Germany and France being for 1901, the others for 1900:

Countries.	Short tons.	Per cent of total.
United States	293,298,516	33.86
United Kingdom	245,332,578	28.32
Germany	168,217,082	19.42
Austria-Hungary	43,010,761	4.96
France	35,596,536	4.11
Belgium	25,856,024	3.00
Russia	17,799,016	2.00
Japan	8,187,262	1.00
Other Countries	28,867,765	3.33
Total	866,165,540	100.00

Lightning does not strike water, Professor J. Trowbridge of Harvard declares. This discovery he has made in his experiments with the highest electromotive force ever used. By means of his battery of 20,000 cells he obtained a voltage of 6,000,000, which force, he says, is at least comparable to lightning, and enabled him to deduce his conclusions. "I found that lightning does not strike water, if there is anything else within reach," says Professor Trowbridge, "in the course of my experiments on the effect of high tension or high electromotive force. With my large battery I was able to obtain an electric spark about seven feet long, and found that instead of striking the water a spark of six or seven feet in length invariably jumped to some adjacent object in preference to striking the liquid surface. A spark of only a few inches in length, however, invariably will strike the water, but such a spark is not, of course, compared to lightning."

The glaciers and snow fields of the upper Alps in Switzerland have been aptly named "white coal" since the mountain torrents having them for their sources, are generally being utilized for power purposes, which means that coal is not required where water power is available. The recent coal strike in this country has been an unpleasant demonstration of the necessity of coal for almost all industries and of the paralyzing effects on business, when it cannot be obtained. We have almost unlimited water power in many parts of the country, but unfortunately it is usually so located as to be unavailable except for such industries as need not be close to the principal markets. The development of the electro-chemical industries as exemplified at Niagara Falls promises that many of these remote water powers may be made useful. The great water power of the streams and rivers in the Rocky Mountains, has often been referred to, but it is doubtful if its vastness is generally appreciated. A project is on foot to harness the Colorado River, near Williams, Arizona. A fall of 5,000 feet can be secured in a distance of about one mile by tunneling. A very small volume of water falling such an immense distance will generate great power, so what will it be for a great river!

A COSTLY TEST.

A few years ago the British Admiralty, in order to carry out certain investigations regarding naval construction and gunnery, had an old battleship turned out to sea where it was sunk and destroyed by a heavy fire from the large guns on the several ships participating in the experiment.

It is now stated that it has been decided to break up the torpedo-boat destroyer *Wolf*, at Portsmouth, with the object of discovering wherein lies the weakness which has led to so many mishaps and disasters in the case of these craft during the present year. The *Wolf*, which was launched in 1897, at a cost of $1,250,000, has been placed in a specially fitted dry dock while awaiting the costly operation. The steel cradles will first be removed from amidships and the vessel will be left hanging by her ends, in order to ascertain if the sagging strain thus imposed is sufficient to break her back. If she survives this ordeal the *Wolf* will be hung see-saw fashion across the cable, both ends being left unsupported, so as to show how she would fare if lifted amidships on the crest of a wave. Other tests will be applied. Great interest centers in the outcome of the experiment, from which the naval architects anticipate obtaining most valuable data for designing future torpedo boat destroyers.

FIRE IN NEW WILLIAMSBURG BRIDGE TOWER.

On the night of November 10 a serious fire broke out in the New York tower of the new Williamsburg Bridge across the East River, which was with great difficulty extinguished. The fire raged fiercest at the top of the tower 330 feet from the ground. The tower construction is entirely of steel, but the fire was fed by the wooden scaffolds, ladders, footbridges, oil, waste, and other inflammable materials used in the construction work. The wires composing the four huge cables had all been laid and were being covered with a waterproofed canvas covering, over which will be placed steel casings. This work had been partially done and it was feared that the cables had been severely damaged over the tower where the flames were the hottest, it even being predicted that they would have to be renewed at a cost of perhaps $1,250,000 which would, in consequence, delay the completion of the bridge more than one year. It was found, however that the cables had been well protected from the direct effect of the flames by the saddles that carry the cables over the top of the tower. A conservative estimate of the damage made by an engineer connected with the Roebling Co. puts the damage at $50,000. Each of the four cables is 18½ inches in diameter, and is composed of 7,696 wires laid in 37 strands of 208 wires each. The wires have a tensile strength of about 200,000 pounds per square inch of cross section. The total width of the new bridge will be 118 feet and the lowest part of the roadway will be 135 feet from the water at high tide. Its total length is 7,200 feet which is about 660 feet greater than that of the Brooklyn Bridge. The center span is 1,600 feet long.

DEVELOPMENT OF WATER POWER AT NIAGARA FALLS.

According to an account recently published in a Buffalo newspaper, the amount of capital now invested in the development of the power of Niagara Falls is $32,500,000. There are at present five companies exploiting the power resources of this famous and wonderful waterfall: Niagara Falls Power Co., Niagara Falls Hydraulic Power & Manufacturing Co., Canadian Niagara Falls Power Co., Ontario Power Co., and Lower Niagara River Power Co. The Niagara Falls Power Co. are now supplying 50,000 electrical horse power from their No. 1 power house and will soon be in position to supply 55,000 horse power from their No. 2 power house, which is nearing completion. The Niagara Falls Hydraulic Power & Manufacturing Co. are enlarging their canal so as to add 100,000 horse power to their present output. The Canadian Niagara Falls Power Co. are working night and day on a 100,000 horse power plant, the output of which will be mostly used on the American side. This company also have a franchise for an additional 100,000 horse power which will probably be developed as soon as the present installation is completed. The Ontario Power Co. have plans for the development of 400,000 horse power and the work is being hurried with all possible speed. The contract for the first 50,000 horse power has been let. The Lower Niagara River Power Co. have secured a franchise for 200,000 horse power which will soon be developed. The total power development possible by these five companies, is about 1,000,000 horse power. The effect of such vast resources of cheap power will undoubtedly be that Niagara Falls and vicinity will eventually become one of the greatest manufacturing centers in the world.

FOR PREVENTING ELECTROLYSIS.

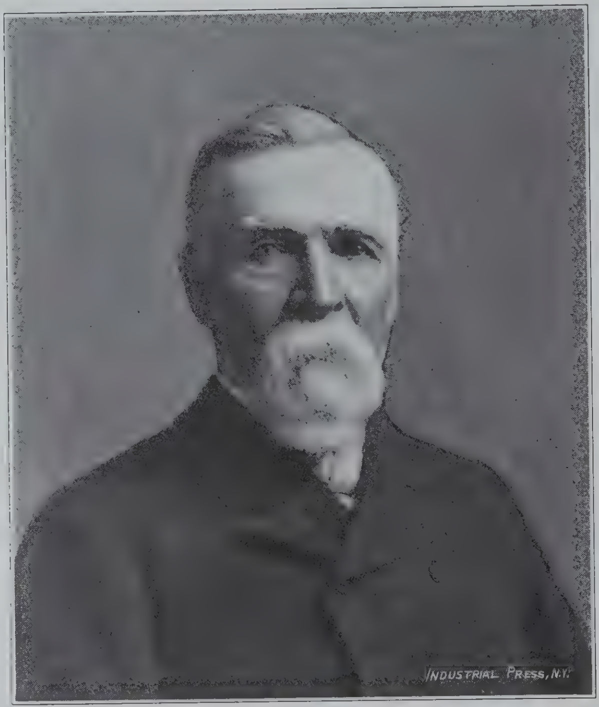
Bearing on the subject of electrolysis, which has become so important in our great cities, are several bits of experience given at a convention of fire engineers in New York City the latter part of September. These were by Capt. Brophy, who read a paper on "Electrolysis." As reported in the *Electrical World and Engineer* he recommends breaking the continuity of metal in pipes by the insertion of insulating joints at suitable intervals. In that case the poorly bonded track would have to receive immediate attention, and its carrying capacity be increased either by proper bonding, increasing the size of the rails, or the addition of return feeders. If neither plan was adopted an increased coal bill would be the result. This plan of placing insulators or circuit breakers was not adopted at first, because none had been devised. But within a quite recent period such breakers have been devised, manufactured and used. Capt. Brophy added:

"In one of our large cities a natural gas system of piping had been connected by a large cable to the dynamos of the street railway system in order to drain them of current, but electrolytic corrosion took place very rapidly at the joints. In this case 'necessity was the mother of invention,' and an insulating joint was devised and inserted at suitable points in the pipe system, and the connection to the dynamos discontinued, since which time no corrosion has taken place.

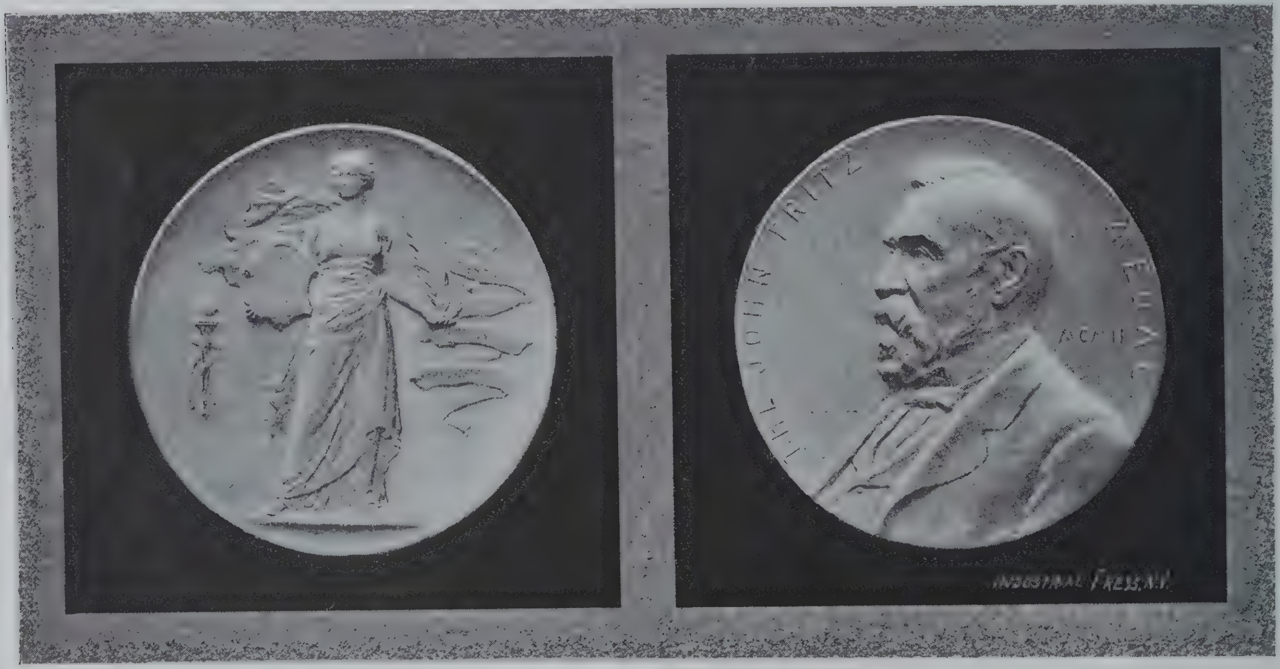
"I have quite recently taken measurements between the natural gas pipes and the rails of the street railway in Wheeling, W. Va., to ascertain the flow of current from pipes to rails, also to ascertain the flow of current in the different lines of pipes. I will not give here a list of these measurements, but as a result of one made near the power house I found 300 amperes flowing from pipe to rail, the pressure being 10 volts, or representing a little over 3 horse power. The gas company has decided to place insulating joints in their pipe system. I have just returned from Wheeling, where the work has progressed far enough to show that the lines wherein these joints have been placed have no current flowing over them, and when the work is completed these pipes will not act as return feeders for the railroad, and electrolytic corrosion will cease. It will be a matter of indifference to the owners of these pipes what the condition of the street railway tracks may be. Not so with the city of Wheeling, however. Up to the present time the return or stray currents were conducted jointly by the gas and water pipes, but from this time on, the entire load must be borne by the water pipe."

THE JOHN FRITZ MEDAL.

A banquet was given at the Waldorf-Astoria Hotel, New York, on Friday evening, October 31, in honor of the eightieth birthday (August 21, 1902) of John Fritz, the well-known veteran of the iron and steel industry of the United States; and a gold medal was given him in recognition of his scientific and industrial achievements. The banquet was attended by nearly five hundred guests, many of whom are among the foremost in the metallurgical industry in this country, and many others equally prominent in other industries and in the professions. Mr. H. C. Prout, editor of the *Railroad Gazette*, was toastmaster on the occasion and Mr. John Thompson made the speech of presentation. Speeches were made by or letters read from Abram S. Hewitt, Rear-Admiral Geo. W. Melville, Brig.-Gen. Eugene Griffin, Andrew Carnegie, Irving M. Scott and many others. Mr. Prout announced the establishment of a John Fritz gold medal to be presented yearly for notable scientific and industrial achievement, without restriction as to sex or nationality. A permanent fund of $4,000 has been raised by the friends of Mr. Fritz, the interest of which will be ample for the annual purchase of the medal. The annual awards of the medal are to be made by a board of sixteen members chosen equally from the membership of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.


INDUSTRIAL PRESS, N.Y.

John Fritz, Engineer. Born August 21, 1822.



Reverse and Obverse of John Fritz Medal.

John Fritz was born August 21, 1822, on a farm in Chester County, Pa., which he left at the age of sixteen to work in a machine shop to learn the machinists' trade. In 1846 he became connected with a bar mill. The tools provided for the building and repair of rolling mill machinery were of the crudest description and were seemingly totally inadequate for such work. The bar mill referred to had practically only one machine tool, a roll lathe. After much persuasion he succeeded in getting the firm to purchase some small lathes, a planer and a drill press. Mr. Fritz's influence was always in the direction of improved tools and appliances, believing that they could always be made a most profitable investment. In 1854 he became connected with the Cambria Iron Works, and about 1860 he erected a puddle and rolling mill and later a blast furnace at South Bethlehem, this being the origin of the great Bethlehem Steel Works. The subsequent development of these works in the manufacture of armor plate for battleships and of hollow steel forgings for industrial purposes by the Joseph Whitworth fluid compression process, are matters of general knowledge.

Mr. Fritz invented and built the first three-high rolling mill in America while superintendent of the Cambria Iron Works. The great difficulties he encountered in its development would have discouraged a man of lesser courage and determination. Before the invention of the three-high mill the two-high rolling mill was in common use. With this the hot plates were returned on top of the upper roll, which of course made an idle pass for each working pass. This not only caused a loss of time, but allowed the plates to cool on the idle pass and made the rolling of large thin plates extremely difficult, if not impossible. The three-high train not only does away with the idle pass and saves time, but keeping the plates continually between the rolls is a distinct advantage, as heat is added mechanically. There is also the tendency to weld up any incipient cracks that may have started in the edges of a plate during the previous pass, because of the reverse action of the rolls. So obvious were the great advantages of the three-high rolling train, after it had once been worked out to a successful issue, that its most strenuous opponents were almost at once won over, and it was not long before it was generally adopted for other rolling mills. To-day it is practically the only form of train known for general work. Probably no other invention has made such a change in the methods or possibilities of the art of forming metal into shapes by the rolling process, or has had a greater influence on the production of iron and steel.

WORM GEARING.

NOTES ON THE DESIGN OF SELF-LOCKING WORM GEARS.

C. F. BLAKE.

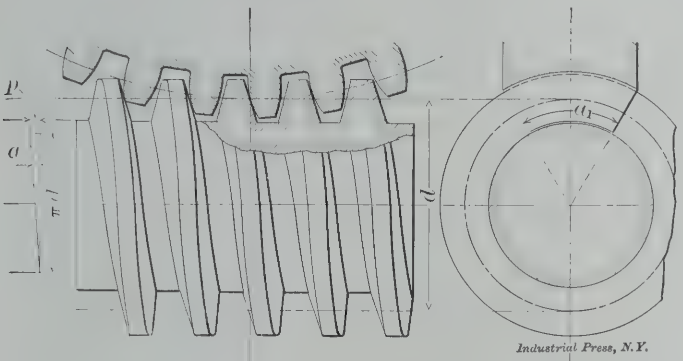
The fact that, among all the valuable matter on gears to be found in the volumes of our technical press, so little rewards the searcher after information on worm gearing, has led to the presentation of the following notes from the writer's note book, being matter obtained from various sources when designing occasional worm gears.

The old opinion that the friction and wear of worm gears are necessarily very great, and that the efficiency is necessarily very low, making worm gearing an unmechanical contrivance, is no longer met with. In Unwin's Machine Design it is stated that in well fitted worm gearing, of speed ratios not exceeding 60 or 80 to 1, motion will be transmitted backwards from the wheel to the worm.

In the *American Machinist* of Jan. 13th and 20th, 1898, Mr. F. A. Halsey, writing on modern practice with worm gearing, shows from many examples of practice that worm gearing may be designed to have a very satisfactory degree of efficiency. In Prof. Forrest R. Jones's work on machine design may be found tabulated the results of many examples from practice, some of which show an efficiency as high as 74 per cent. before abrasion began, the most notable example being that of a worm running at a surface speed of 306 feet per minute under a load of 5,558 pounds, and showing an efficiency of 67 per cent., with no abrasion. The tables in Prof. Jones' work show that under light loads very high surface or rubbing speeds are allowable, running as high as 800 feet per minute, while Mr. Halsey gives diagrams showing the relations of the rubbing speeds, thread angles and efficiency, showing in general that an increase in the thread angle increases the efficiency.

There is, however, an important function of worm gearing which is not brought out in these articles, and which in certain classes of machinery is of the first importance; often, indeed, becoming the determining factor in deciding upon the choice of a worm gear as the power transmitter. It is the property a worm gear possesses, under certain conditions as to its design, of being self-locking, and preventing motion backwards.

An instance where this property becomes of prime importance and accounts for the use of the worm gear, is in crane work, where the winding drum is driven by a worm gear so designed that when the power is shut off the gear will not run down or backwards under the impulse of the load, but will be self-locking, holding the load at any point.



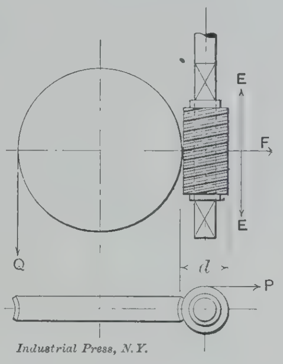
Industrial Press, N.Y.

Fig. 1. Single Thread Worm in Mesh with Wormwheel.

Fig. 1 shows a single thread worm in mesh with the worm wheel, a being the angle of the worm thread with the axis of the worm wheel, and in order that the system may be self-locking, that is that the worm wheel may be unable to run the worm, the tangent of the angle a, must be less than the coefficient of friction between the teeth of the worm and wheel, or as

$$\tan. a = \frac{p}{\pi d}, \text{ so } \frac{p}{\pi d} < f \quad \ldots\ldots\ldots\ldots (1)$$

in which p = the pitch, d = the pitch diameter of the worm, and f = the coefficient of friction between the worm and wheel. It is necessary to assume a value for f, which, if the condition determining the use of the worm gear is its self-locking property, should be assumed conservatively low. Unwin states under the authority of Prof. Briggs, that a well-fitted worm gear will exhibit a lower coefficient of friction than any other description of running machinery. Prof. Jones gives a series of values for the coefficient of friction of screw gears, one of which is a pinion of 4 inches pitch diameter, the average value being f = .05 corresponding to a rubbing velocity of 250 feet per minute. Mr. Halsey in his articles assumes f = .05, and Mr. Wilfred Lewis says that when the worm gear is worked up to the limit of its safe strength, a rubbing velocity greater than 200 to 300 feet per minute will prove bad practice. It is in heavy machinery where worm gears are mostly used as self-locking transmission elements, and here they are usually worked up to the safe strength of the wheel, hence it is fair to assume f = .05 when designing a self-locking worm gear, and to limit the rubbing velocity to 200 feet per minute, and we have for the limiting value of p at which the system will be self-locking.



Industrial Press, N.Y.

Fig. 2.

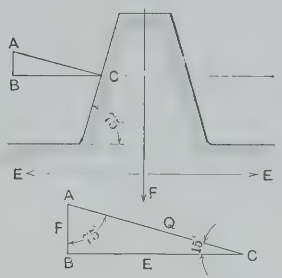


Fig. 3.

$$p = .05\,\pi\,d = 0.157\,d \quad \ldots\ldots\ldots\ldots\ldots (2)$$

The sliding velocity in feet per minute at the pitch line is expressed by

$$V = \frac{\pi\,d\,n}{12} = 0.261\,d\,n \ldots\ldots \quad \ldots\ldots\ldots (3)$$

where d = the pitch diameter of the worm, and n = the number of revolutions per minute of the worm.

Under the above assumption, that for continuous service and heavy pressures, the sliding velocity should not be more than 200 feet per minute, we have as the limiting value of d to avoid all cutting,

$$d = \frac{200}{0.261\,n}$$

The exact nature of the surface of contact between a worm and wheel is involved in doubt; many claim it is only a point; it certainly is not large, and consequently a wide face for the wheel is not needed. If the angle a_1 is made 60 degrees, it will make the face right for any ordinary worm of 4 to 6 inches diameter.

There is in all worm gearing a very heavy end thrust on the worm shaft, and also an outward force normal to the worm axis, each of which must be suitably provided for in the design of the shaft and bearings. The end thrust may be taken by bronze washers slipped into the bearings at the end of the shaft, which may be removed when worn and replaced with new ones. Shoulders may be provided on the shaft, between which and the bearings bronze collars may be placed, these being split to enable new ones to be easily and quickly placed in position when the old ones become worn. Roller thrust bearings are very often applied to worms, and these as well as the bronze washers may be supplied with adjusting setscrews to take up the wear instead of renewing the washers.

In Fig. 2 let P = the tangential force at the pitch line of the worm, d = the pitch diameter of the worm, Q = the tangential force at the pitch line of the worm wheel, E = the end thrust of the worm shaft, F = the force on the worm shaft normal to the worm axis, then, friction being neglected,

$$Q = \frac{P\,\pi\,d}{p} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

In Fig. 3 let the force Q be represented by the line A C normal to the tooth side of the worm at the pitch line; draw A B normal to the axis of the worm, and B C parallel to the axis or coincident with the pitch line of the worm; then when measured to the same scale to which A C was drawn, A B = F, and B C = E. As the angle C A B is 75 deg. (for the 15 deg. involute system) we have,

$$\frac{F}{Q} = \text{sin. } 15°, \text{ and } F = 0.258\ Q \ \ldots\ldots\ldots\ (5)$$

$$\frac{E}{Q} = \text{cos } 15°, \text{ and } E = 0.966\ Q \ \ldots\ldots\ldots\ (6)$$

Taking friction into consideration, the force P_1 tangential to the pitch line of the worm, which it is necessary to employ

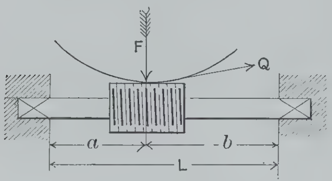


Fig. 4.

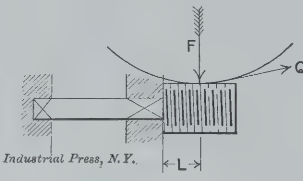


Fig. 5.

in order to produce a force Q tangential to the pitch line of the wheel, is given in Weisbach as

$$P_1 = Q\,\frac{h + f}{1 - h f} \ \ldots\ldots\ldots\ \ldots\ldots\ (7)$$

in which

$$h = \frac{p}{\pi\, d}$$

The efficiency of the worm and wheel is then,

$$\frac{P}{P_1} = e \ \ldots\ldots\ldots\ldots\ldots\ldots\ (8)$$

Example: A single thread worm of 1 inch pitch running 80 rev. per min. is to transmit to a worm wheel a tangential force Q = 5,000 pounds, and is to be self-locking.

Here from (3)

$$d < \frac{200}{.261 \times 80},$$

or d may be as large as 9.6 inches before abrasion need be feared.

From (2)

$$p < 0.157\ d, \text{ assume } p = .125\ d,$$

then as p = 1 inch, d = 8 inches, or the worm will require to be 8 inches pitch diameter in order that the angularity of the thread may be small enough to make the system self-locking. It will be seen that the required diameter will be increased as the value of f is decreased, and in case the required diameter of the worm proves too great for practice, and the pitch cannot be reduced on account of considerations of strength, some outside aid, such as a brake or friction disk applied to the worm shaft, will have to be adopted.

From (7),

$$\text{as } h = \frac{p}{\pi\, d} = \frac{1}{3.14 \times 8} = .039, \text{ we have}$$

$$P_1 = 5000\,\frac{.039 + .05}{1 - (.039 \times .05)} = 445 \text{ pounds.}$$

From (4),

$$5000 = \frac{3.14 \times 8 \times P}{1}, \text{ or } P = 199 \text{ pounds.}$$

From (8),

$$\frac{P}{P_1} = \frac{199}{445} = 44\% \text{ for the efficiency of the worm gear.}$$

The formulas may, by starting with those for the efficiency, be used to determine the pitch diameter which will give the proper thread angle for any given pitch and degree of efficiency.

It is clear from the foregoing, that a worm gear of large pitch will require a pitch diameter of the worm altogether too large for practice if it is to be self-locking, and that the system as usually designed may be expected to run backwards. To prevent this, a friction disk may be placed in the bearing which receives the thrust of the worm shaft when the system is running backwards, and the diameter of the disk so proportioned as to just hold the worm shaft stationary under the impulse of the worm wheel.

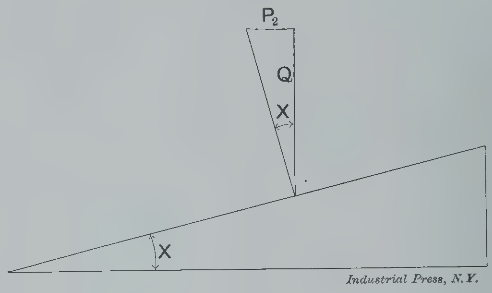


Fig. 6.

The foregoing discussion neglects the effect of the thrust of the worm shaft in its bearings, the frictional resistance of which must be added to that of the teeth to obtain the actual conditions of a self-locking system. This frictional resistance depends upon the values of the end thrust E and the normal force F already found, and the diameter and form of the bearing. In nearly all cases of worm gearing the mounting of the worm upon the shaft will be covered by one of three cases, either unsymetrically between the bearings, symetrically between the bearings, or over-hung.

Case 1, Fig. 4, the bending moment upon the worm shaft is,

$$M = \frac{F\,a\,b}{L} = \frac{.258\ Q\,a\,b}{L} \ \ldots\ldots\ldots\ldots\ (9)$$

Case 2, the same as Case 1, except that the worm is central between the bearings, and

$$a = b = \frac{L}{2}$$

the bending moment upon the worm shaft is,

$$M = \frac{.258\ Q\,L}{4} = .0645\ Q\,L \ \ldots\ldots\ldots\ (10)$$

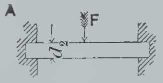
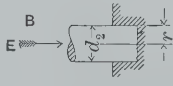
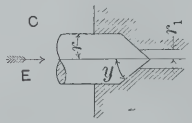
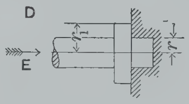
Case 3, Fig. 5, the bending moment upon the worm shaft is,

$$M = F\,L = .258\ Q\,L \ \ldots\ldots\ldots\ldots\ (11)$$

In each of the above cases the shaft is subjected to a combined twisting and bending strain, the twisting moment being the same in each case, T = P R, which is, however, so small as to be negligible in what follows.

In the following table the first column shows the several styles of journals most commonly used for worm shafts, the second column gives the moment of friction for each under a load in the direction of the arrow, the third column gives the coefficient of friction assumed, and the fourth column gives the tangential force P_2 at the pitch line of the worm resulting from the resistance of friction in the journals, and found by dividing the moment of friction in column 2 by the pitch radius of the worm.

TABLE GIVING MOMENT OF FRICTION WITH VARIOUS TYPES OF BEARINGS

Style of Journal.	Moment of Friction.	f	$\frac{\text{Moment of Friction}}{R}$
A 	$\frac{f\,F\,d_2}{2}$	.05	$\frac{.04\ P\,d_2}{p}$
B 	$\frac{2\,f\,E\,r}{3}$	.05	$\frac{.2\ P\,r}{p} = \frac{.1\ P\,d_2}{p}$
C 	$\frac{2\,f\,E\,(r^3 - r_1^3)}{3\,r\ \text{sin. } y}$	.05	$\frac{.2\ P\,(r^3 - r_1^3)}{p\,r\ \text{sin. } y}$
D 	$\frac{2\,f\,E\,(r_1^3 - r^3)}{3\,(r_1^2 - r^2)}$	.05	$\frac{.2\ P\,(r_1^3 - r^3)}{r_1^2 - r^2}$

There are always acting upon the worm shaft the two forces F and E; consequently to get the resultant retarding force tangential to the pitch line of the worm, we must take the sum of the resultants due to the frictional resistance of each force separately. Referring to the table we will, for each worm shaft, find the conditions shown at A, in addition to the conditions shown either at B, C or D, as the case may be, and the total resultant force P_2 at the worm pitch line, will be the sum of the quantities given in column 4 opposite the particular cases.

These frictional resistances developed by the journals act in a direction helpful to the self-locking property of the worm, and enable the designer to use a larger thread angle for a given diameter of worm, or a smaller diameter of worm for a given thread angle, thus getting within the limits of good practice, and increasing the efficiency of the system for the forward movement.

Having determined the force P_2 tangential to the worm pitch line, resulting from the frictional moment at the journals, the angle of repose for this force acting with the force Q, as shown in Fig. 6, is given by the equation,

$$\tan.\ x = \frac{P_2}{Q}$$

The thread angle found previously to the consideration of the effect of the journal friction may now be increased by the angle x, making the thread angle a+x. This may be accomplished either by increasing the thread angle, increasing the pitch, or decreasing the pitch diameter.

Consider, now, that in the foregoing example, the worm shaft is of the form of Case 2, the worm being central between the bearings, and the distance between bearings being 36″.

Then from (5) we have,

$$F = .258 \times 5{,}000 = 1{,}290 \text{ pounds,}$$

and from (6)

$$E = .966 \times 5{,}000 = 4{,}830 \text{ pounds.}$$

From (10)

$$M = \frac{.258 \times 5000 \times 36}{4} = 11610 \text{ inch pounds.}$$

Assuming $f = 10{,}000$ pounds per square inch for the allowable fiber strain in the worm shaft, we have

$$M = \frac{\pi}{32} d_1^3 f \text{ or } d_1 = 2.28''$$

From the table, Case A.

$$P_1 = \frac{.04 \times 199 \times 2.28}{1} = 17.21 \text{ pounds.}$$

From the table, case B.

$$P_1 = \frac{.1 \times 199 \times 2.28}{1} = 45.37 \text{ pounds.}$$

Then

$$P_2 = 17.21 + 45.37 = 62.58 \text{ pounds.}$$

$$\tan.\ x = \frac{62.58}{5000} = .0125$$

$$x = .7^\circ$$

From (1).

$$\tan.\ a = \frac{1}{3.14 \times 8} = .039$$

$$a = 2.25^\circ$$

Then

$$a + x = 2.95^\circ$$

$$\tan.\ 2.95^\circ = .052$$

$$\frac{p}{\pi d} = .052 = h, \text{ and } d = 6''.$$

If now we substitute these new values of h and d in equations (7) and (4) we shall have,

From (7),

$$P_1 = 5000 \frac{.052 + .05}{1 - (.052 \times .05)} = 500 \text{ pounds-}$$

From (4),

$$5000 = \frac{P \times 3.14 \times 6}{1} \text{ or } P = 270.7 \text{ pounds.}$$

From (8),

$$\frac{P}{P_1} = \frac{270.7}{500} = 54\% \text{ efficiency for the worm gear.}$$

The total efficiency of the system, taking account of the journal friction will be

$$\frac{P}{P_1 + P_2} = \frac{270.7}{500 + 62.58} = 48\%$$

It thus becomes clear that while the efficiency of the worm threads and wheel teeth has been increased above 50 per cent, the efficiency of the whole system including the journals is below 50 per cent. and the system retains its self-locking property. It is evident that when running forward the end thrust E upon the worm shaft will be upon the opposite end from that when running backwards, and on this account a system may be designed to have a high efficiency on the forward movement and still preserve its self-locking property.

If both the journals be made roller bearings, and the end taking the thrust on the forward movement be made ball bearing, while the opposite end be made like Case C or D in the table properly proportioned, the worm may be designed to show a very high efficiency on the forward movement, while the frictional resistance of the step bearing on the opposite end will cause the system to be self-locking by reason of the energy absorbed at the step bearing.

The formulas may be put into more convenient form for this purpose, as follows:

The designer will have, to start with, a knowledge of the force Q required at the worm wheel, the force P_1 at the pitch line of the worm developed from the source of power, the pitch required for the worm wheel, and the efficiency e for which he wishes to design the system. We then have,

$$\frac{P}{P_1} = e, \text{ and } P = P_1\, e$$

Substituting this value for P in equation (4) and solving for d we have,

$$d = \frac{p\, Q}{3.14\, P_1\, e}$$

for the worm neglecting the journals, when the journals and thrust are roller and ball bearings respectively, and

$$d = \frac{p\, Q}{3.14\, (P_1 - P_2)\, e}$$

when the journals and thrust bearings are considered.

The worm being thus designed for the given efficiency on the forward movement, it remains to determine such proportions of the step bearing for the backward movement as will present enough frictional resistance to render the system self-locking. Let e_1 = the efficiency when the journals and thrust are considered, then

$$\frac{P}{P_1 + P_2} = e_1 \text{ or } P = e_1\, (P_1 + P_2)$$

and substituting the value of P found above

$$e\, P_1 = e_1\, P_1 + e_1\, P_2$$

and

$$P_2 = \frac{P_1\, (e - e_1)}{e_1}$$

By equating this force P_2 to the proper quantity from column 4 in the table of journal resistances the proportions required of the journal or step bearing may be determined.

* * *

The British cable-laying ships have completed the laying of the Pacific cable from Vancouver to Sydney, Australia. This is the first cable across the Pacific, but others will probably follow soon. No serious trouble appears to have been encountered laying the cable over the submarine valley six miles deep that must be crossed, and which has been the chasm feared by cable companies.

TESTING INDICATOR SPRINGS.

NEW APPARATUS AT THE NEW YORK NAVY YARD FOR THIS PURPOSE.

As far as we have been able to determine, the first indicator testing apparatus in which the attempt was made to approach the conditions of practice, was built at the Brooklyn Navy Yard, now the New York Navy Yard, in 1888. This apparatus was for testing springs under static steam pressure and has served as a model for other testing devices in various engineering laboratories. At the time of the Navy Yard fire three years ago (Feb. 15, 1899) the building containing the testing room was destroyed and when the new Navy Yard buildings were put up, a larger and more complete testing room was equipped—one of the many improvements under the direction of Commander J. A. B. Smith. A new indicator testing apparatus was built, embodying novel features, many of which had been worked out by Mr. Chas. A. Webb, the instrument maker in charge of the room. This apparatus is designed for both static and dynamic tests of springs. Under the latter arrangement the scale of a spring is determined while both the pencil and the drum of the indicator are in motion and a diagram is being traced. By this method the inertia effects of piston, spring and pencil levers are the same as when the indicator is used on a steam engine. The dynamic method of testing springs is original with Prof. C. H. Peabody, of the Massachusetts Institute of Technology, Boston, who designed the first machine for this purpose. Those who have copies of the February '99 issue of MACHINERY will find therein a description, both of the original Brooklyn Navy Yard apparatus and of Prof. Peabody's machine.

When testing a spring it is placed in its proper position in the indicator and the instrument is attached to a steam cylinder corresponding to the cylinder of a steam engine. The indicator drum receives an oscillating motion similar to the motion that it would receive from an indicator reducing motion on a steam engine. Steam is admitted to and exhausted from the steam cylinder, thus giving motion to the indicator pencil in substantially the same manner as when the admission and exhaust take place in an engine cylinder. Mercury gages are used for showing the admission and exhaust pressures in the cylinder so that they may be compared with the corresponding pressures indicated by the pencil lines of the diagram.

In Fig. 3 are typical diagrams reproduced full size and taken with a 100-pound spring. The figures on the diagrams indicate the admission and exhaust pressure in each case. The three upper diagrams were taken at pressures above the atmosphere and the three lower diagrams at pressures below the atmosphere, or in a vacuum. Further reference will be made to these below.

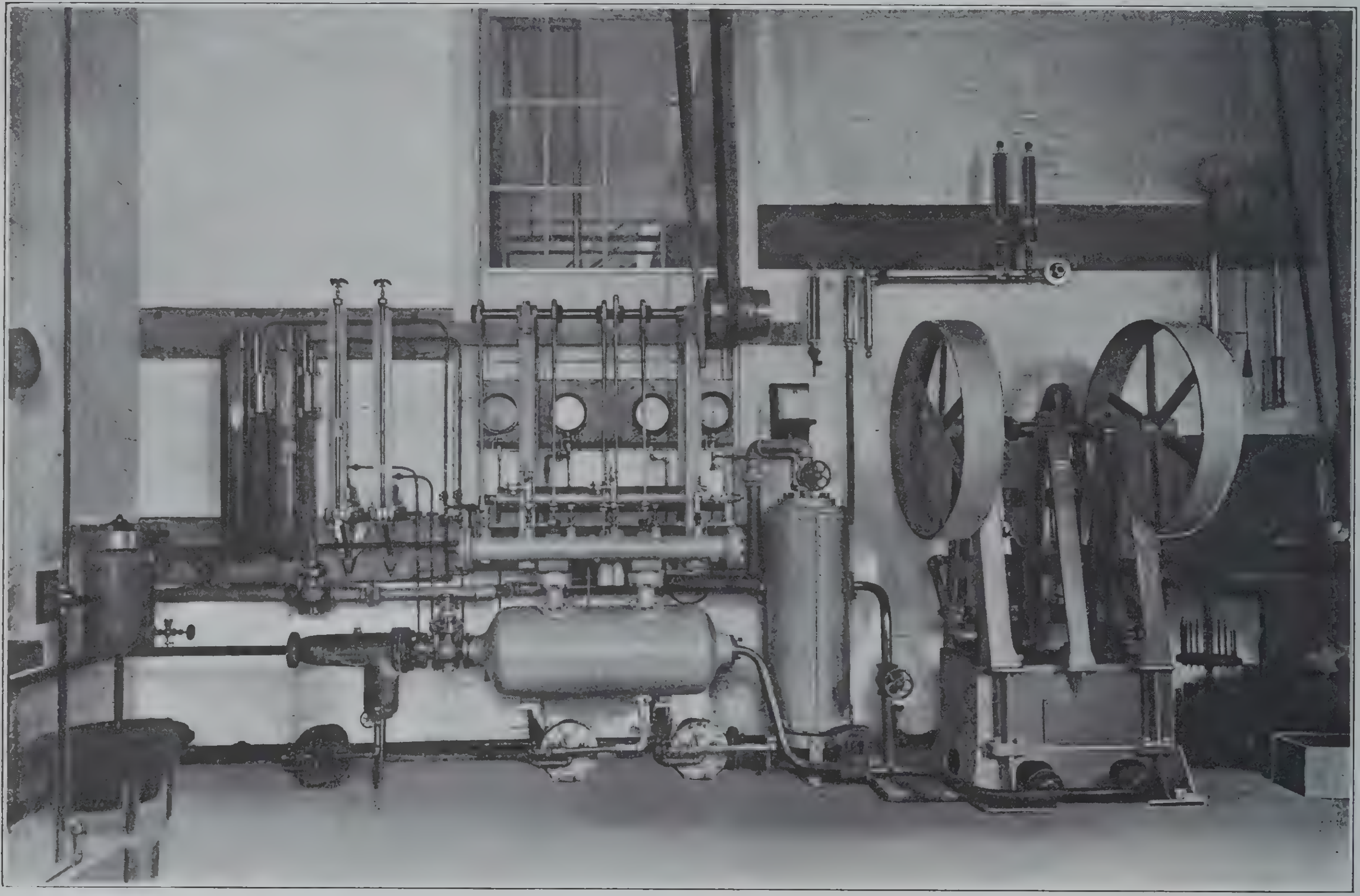


Fig. 1. New Apparatus at the New York Navy Yard for Testing Indicator Springs.

The New York Navy Yard Apparatus.

A general view of the new Navy Yard apparatus is shown in Fig. 1, and details appear in the succeeding illustrations. While it embodies the same principle as Prof. Peabody's dynamic tester, it is modified to permit a number of indicators to be tested at the same time, and the general arrangement of the various parts is quite different from that in the original machine.

An essential element of the apparatus is the cylinder *AA*, Fig. 2, to or from which steam can be admitted or exhausted, as mentioned above, and having the bosses *ggg* for the reception of the indicators to be tested. The shaft *BB* at the top of the machine is driven by an electric motor and has five eccentrics, the left one of which connects with a crank on the end of the drum *EE* to which the indicator strings are attached by thumb screws, thus giving motion to the indicator drums. Two other eccentrics operate piston valves, entirely similar to the ordinary slide valve, in the valve chambers *bb*. These serve first to admit steam from the reservoir *C* to the manifold cylinder *AA* and secondly to exhaust the steam from the latter cylinder to the exhaust reservoir *D*. Finally two middle eccentrics operate small piston valves in the casting *cc*, one of which momentarily admits steam at the admission pressure to the base of one of the mercury gages at *M;* and the other valve momentarily admits steam to the other mercury gage at the exhaust pressure.

To explain the formation of the diagrams of Fig. 3, a typical diagram has been drawn, Fig. 4, upon an enlarged scale, with reference letters. The line *ab* is the admission line, admission being for a very brief duration, as when an engine is running with an extremely short cut-off. The inertia of the pencil carries the admission line too high at first and so connection with the mercury gage is not made until it has settled to its normal level at *c*. The connection is only for an instant and steam at admission pressure is bottled up, as it were, in the base of the mercury gage. When the machine is running at its usual speed the height of the mercury remains at an almost constant level and can be easily read, a vernier attachment being used to determine tenths of pounds. From *d* to *e* is exhaust, and when the normal exhaust level is reached, at *f*, connection with the other mercury gage is made, for registering the exhaust pressure. This in brief is a general description of the machine, but there are numerous interesting features that should be treated more in detail and which receive attention below.

Regulating the Steam and Exhaust Pressures.

Continuing with Fig. 2, the steam enters the reservoir *C* through a De Rycke separator and the reducing valve *d*. It is manifestly necessary to have different pressures of steam in the reservoir in order to test the springs under different degrees of compression. With a static apparatus, where but little or no steam escapes from the reservoir, this can be easily accomplished by means of a globe valve. In this case steam is being drawn from the reservoir in greater or less amounts and a reducing valve is essential. A great deal of difficulty was experienced in securing a valve that would keep the pressure absolutely constant when operating between wide limits, and the one finally adopted after severe tests was the Leslie reducing valve, made by J. S. Leslie, Paterson, N. J. The exhaust reservoir *D* has an outlet to the atmosphere through an exhaust pipe in which is placed the reducing valve *e*, so that any degree of back-pressure can be secured. If desired to run a test under vacuum corresponding to conditions when indicating a condensing steam engine, connection is to be had to an air pump through the pipe shown at the right of the exhaust reservoir. All of these various parts drain into Kieley traps, as indicated.

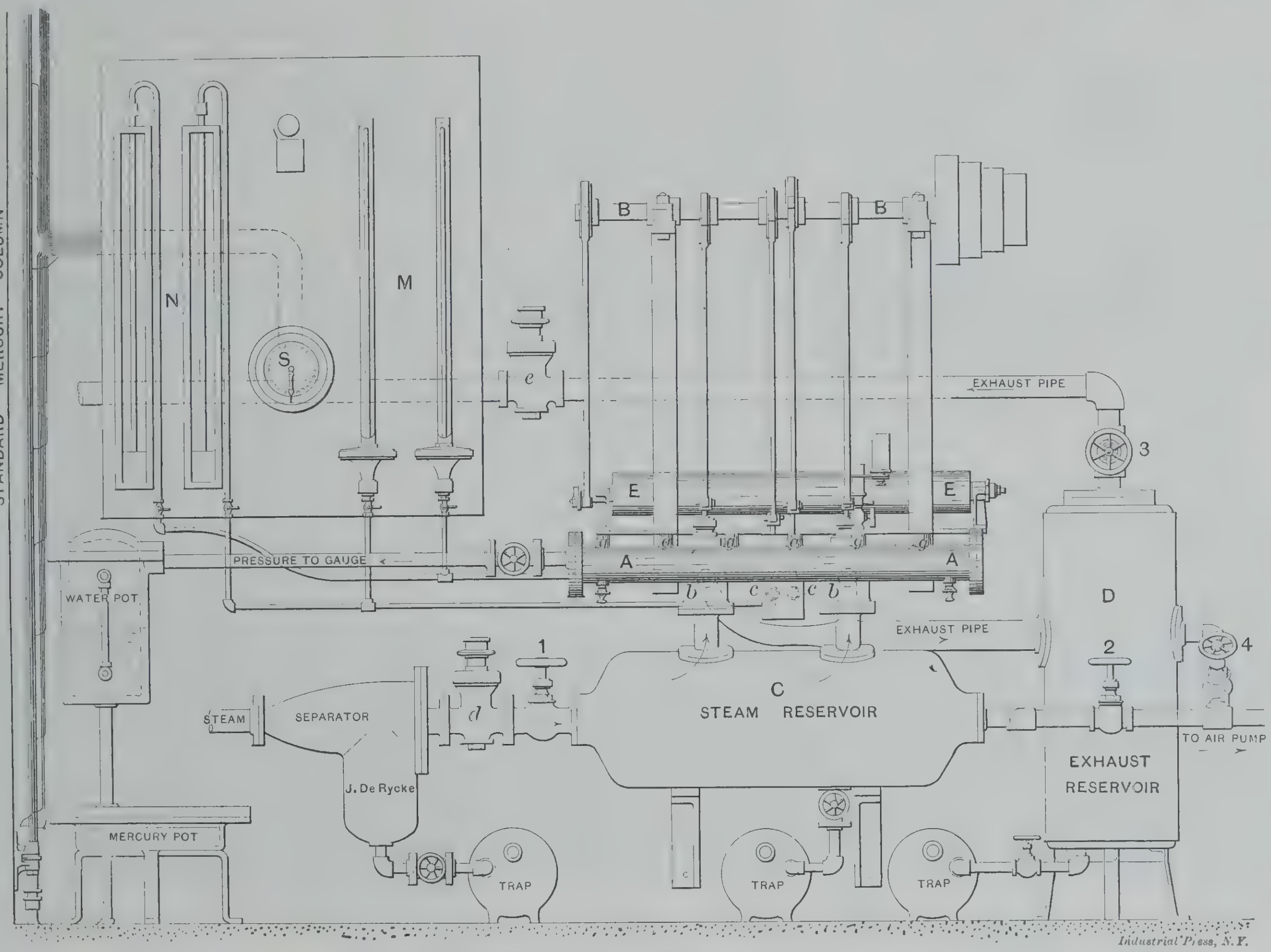


Fig. 2. Diagram of New York Navy Yard Indicator Spring Testing Apparatus.

Vacuum Tests.

Should it be desired to test a spring at pressures below atmospheric pressure only, the steam line being below the atmospheric line, it is possible to do so by two different methods. It will be noted that the steam reservoir can be connected directly to the air pump by valve 2 and can be opened to steam pressure by valve 1. The exhaust reservoir can be connected to the air pump by valve 4 and can be opened to atmospheric pressure by valve 3. When making vacuum tests, therefore, the pressure can be so regulated that either the steam or the exhaust reservoir can be used for the higher pressure, the other one serving for the lower pressure. Thus by opening valve 1 slightly and throttling at valve 2, the pressure can be maintained in the steam reservoir at any desired amount below atmospheric pressure, this being used when tracing the upper line of the diagram. The exhaust reservoir would then be opened to the air pump, valve 3 being closed.

The other method would be to open valve 3 and throttle at valve 4, giving a pressure in the exhaust reservoir slightly less than atmospheric pressure; and to close valve 1 and open wide valve 2, which would give the air pump pressure, or the complete vacuum in the steam reservoir. By either of these methods diagrams similar to the three lower ones in Fig. 3 would be traced.

When making vacuum tests the vacuum gages at *N* are used, instead of the mercury columns at *M*. The vacuum gages were made by the Hohmann & Mauer Co., Rochester, N. Y. The mercury columns *M* were made by the Quimby Steam Engineering Co., Philadelphia, and are of novel design. While they are capable of measuring pressures up to 300 pounds the total rise of the mercury is only 36 inches for 300 pounds pressure, this short rise being accomplished by means of an arrangement for compounding pressures, in the base of the column.

Details of Construction.

In Figs. 5 and 6 are shown sections through the valves and valve chambers, which admit steam to and exhaust it from the manifold cylinder and which connect the latter with the pressure and vacuum gages. Fig. 5 shows the valve for admitting steam to the gages. It is a hollow piston valve having holes at *a* and *b* which, when they come opposite holes *A* and *B* in the casing, allow steam to flow through. It will be understood that the manifold cylinder is represented in section at *C*. In Fig. 6 the manifold cylinder is also shown at *C* and the piston valve indicated allows steam to enter from the bottom in the direction of the arrow and to pass out from the cylinder through the upper port into the exhaust passage *E*. It will be noted that the valve is balanced.

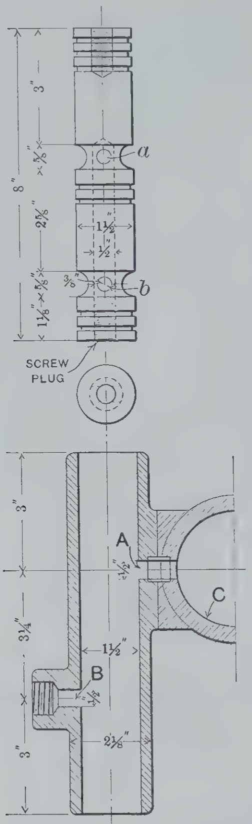
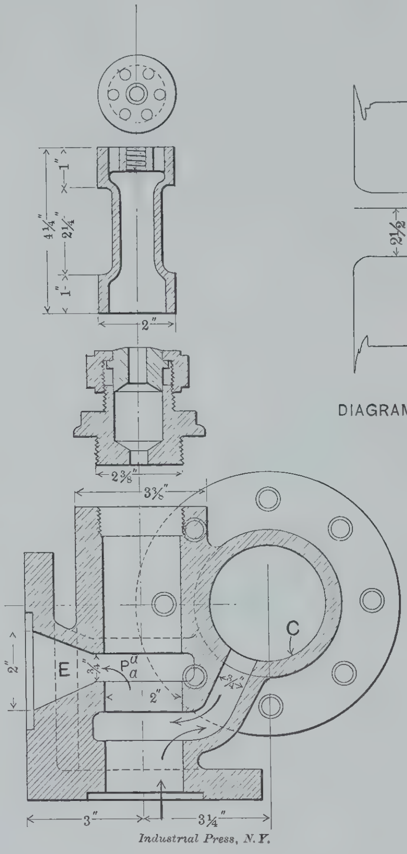


Fig. 5.



Industrial Press, N.Y.

Fig. 6

Details of the drum to which the indicator strings are attached for giving motion to the indicator drums are shown in Fig. 7. It will be evident that for the purpose of testing springs it is not necessary to trace a long diagram, one an inch long serving every purpose that would be accomplished by having a card four or five inches long. It was a matter of convenience, therefore, to provide for adjusting the positions of the indicator drums when taking cards, so that two or three diagrams can be traced side by side on the same piece of paper, as in Fig. 3. To accomplish this the drum is made so that it can be rotated a slight amount by hand, independently of its connection with the eccentric, the effect of this adjustment being the same that would be accomplished by lengthening or shortening the strings of the indicators. The mechanism for making this adjustment is shown in Fig. 7. The hub *H* of the drum is hollow and in making this angular adjustment it rotates upon tube *B*. When the drum is oscillated by the eccentric, however, the tube and drum turn as one piece, being locked together by the pin *P*. To accommodate the pin there are two diagonally opposite spiral slots in the hub of the drum and two straight axial slots in the tube. The pin is carried by a cylindrical piece *C* which can be moved endwise by a crank or handwheel on the end of screw *S* in the lower view, Fig. 7. Inasmuch as the pin is constrained to move in a straight line longitudinally with the drum by means of the straight slots in the tube *B*, the drum must turn one way or the other through the influence of its spiral slots. A complete sectional view of the drum appears in Fig. 8, showing the lever attached to the tube or hollow shaft at the left, through which the drum is oscillated by means of its eccentric.

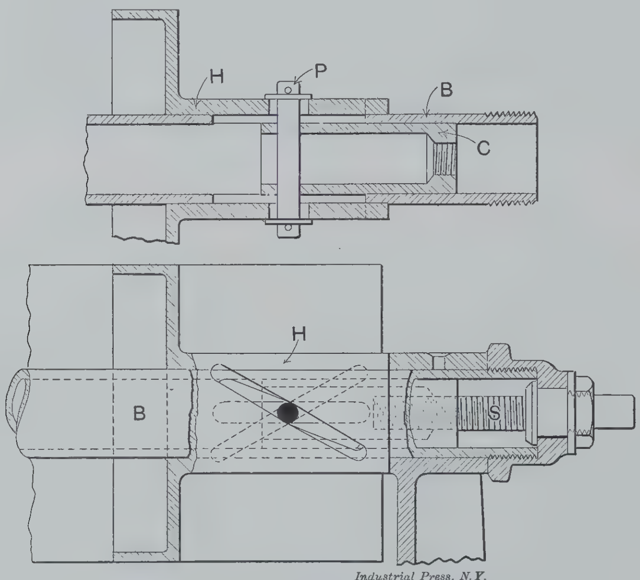


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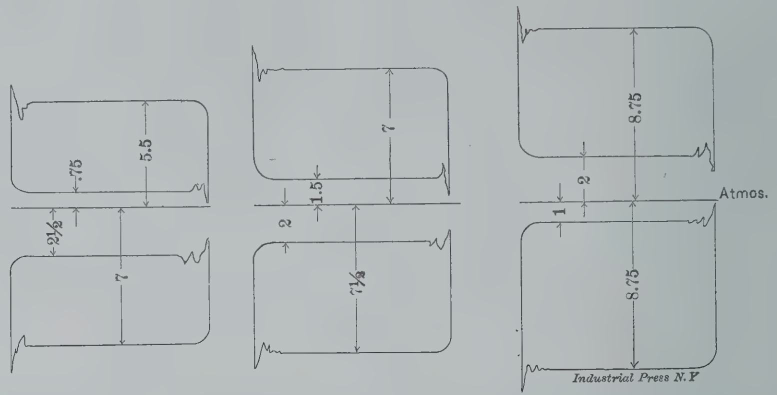
Fig. 7. Drum Adjustment Mechanism.



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DIAGRAMS WITH 10 LB. SPRING BOTH ABOVE AND BELOW THE ATMOSPHERIC LINE

Fig. 3. Typical Diagrams reproduced Full Size.

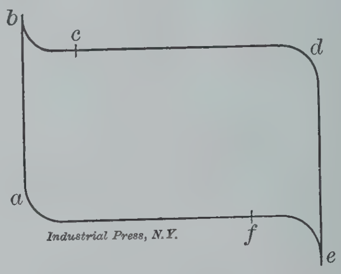

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Fig. 4. One of the Diagrams Enlarged.

Static Tests.

The original Navy Yard apparatus was for testing springs under static pressure only. This is the method that is still used, pending more complete tests with the dynamic apparatus above described, provision being made for this. The standard mercury column is shown at the extreme left in Fig. 2 and is used not only for testing springs but for standardizing gages and the smaller columns used with the dynamic tester. When testing under static pressure the connection between drum *E* and its eccentric is broken. The indicator strings are attached to the drum and the latter is turned and set by hand in such a position that the different indicator drums will have been rotated slightly. An electrical device is shortly to be added whereby the main drum *EE* can be released, allowing the indicator drums to fly back to their original positions through the action of their own

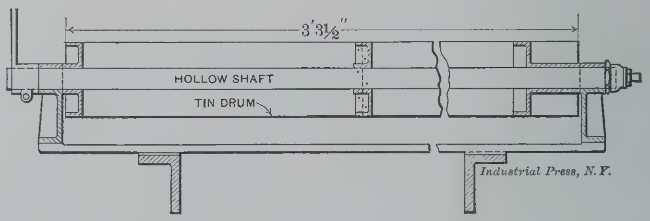

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Fig. 8. Sectional View of Drum.

springs, and the indicator pencils to be applied to the paper simultaneously, which will trace a mark about $\frac{3}{8}$ inch long. This part of the apparatus has not yet been completed.

This electrical connection will be made automatically through the mercury column at 5-pound intervals, the switch *S*, Fig. 2, being used for the purpose. The column is connected by wires with the switch, and as the mercury rises, contact will be made when it reaches the point corresponding to that at which the switch is set. By moving the switch point by point, and increasing the pressure under the mercury column, a spring may be tested at 5-pound intervals throughout its whole range. The method of varying the height of the column of mercury will be evident from Fig. 2. Steam is admitted from the manifold cylinder *A* to the water pot, forcing water down into the mercury pot and in turn forcing mercury into the column. When testing springs under vacuum by the static method the vacuum gages *M* are used, the same as when making the dynamic tests.

* * *

RE THE METRIC SYSTEM.

A recent news item states that a printing ink factory of mammoth proportions will soon be built near Paris, France, by Cincinnati, Ohio, capitalists. The building is to be of peculiar fireproof construction. Fireproof brick will encase the steel frame, and the doors and outside window shutters will be constructed of steel with layers of asbestos in the center. Then follows a remarkable statement by the president of the company to the effect that although the plans have been drawn in Cincinnati, they will have to be redrawn by a French draftsman as the drawings in France must be made to metric measurements. While we are not prepared to dispute that the drawings may have to be redrawn in France to conform to certain requirements of the French building laws, we certainly shall challenge the implication that the Cincinnati draftsmen cannot make them on account of the metric measurements. In fact, the chief contention of the advocates of the metric system is that it is particularly well adapted for drafting room use. While it is generally admitted that it is not as convenient for constructive work in the shop as a system divisible by four, it is assumed that for draftsmen and designers, who have calculations to make, the decimal system is much to be preferred.

THE "HERCULES" FLOATING CRANE AT THE NEW YORK NAVY YARD.

A floating crane of gigantic proportions has been completed by the Brown Hoisting Machinery Co., Cleveland, O., for the New York Navy Yard, which will be used in the construction of the battleship Connecticut as well as in the repair work that is being constantly done. The illustration shows the crane moored at a dock in the Navy Yard, just as it was lifting a test weight of 115 tons, consisting of heavy engine shafts, etc. The crane is supported upon a steel pontoon 100 feet long, 60 feet wide and 11 feet deep. The runway on which the trolley travels is over 200 feet long, projecting at either end about 50 feet. The cables are of sufficient length to enable the crane hooks to be lowered to a depth of 20 feet below the water level, and the structure is tall enough so that they can be raised to a height of 65 feet above the water.

The pontoon is divided into three main longitudinal compartments. On one side are the boilers, on the other side the steam capstans and in the center is a counterweight weighing 250 tons. In floating cranes it has generally been customary to keep the pontoon level and the crane in an upright position by filling or emptying large water tanks placed at either end when heavy weights were to be lifted. In this crane, however, the very novel plan is adopted of a moving counterweight, shown in Fig. 2, which travels on four tracks. The counterweight is moved backwards and forwards by a cable under the control of a steam engine, which operates automatically through the action of a float in a water tank in which the level of the water is governed by the inclination or depression of the pontoon. Assuming a heavy weight to be hoisted at one end of the runway, that end of the pontoon will depress, causing the water to flow into the tank, raise the float—which opens the throttle valve—and start the engine connected with the counterweight. The latter travels towards the other end of the pontoon until the balance is restored, when the position of the float changes and the engine stops. Should the weight being lifted be racked along the runway, the counterweight would move continuously, keeping the pontoon in balance.

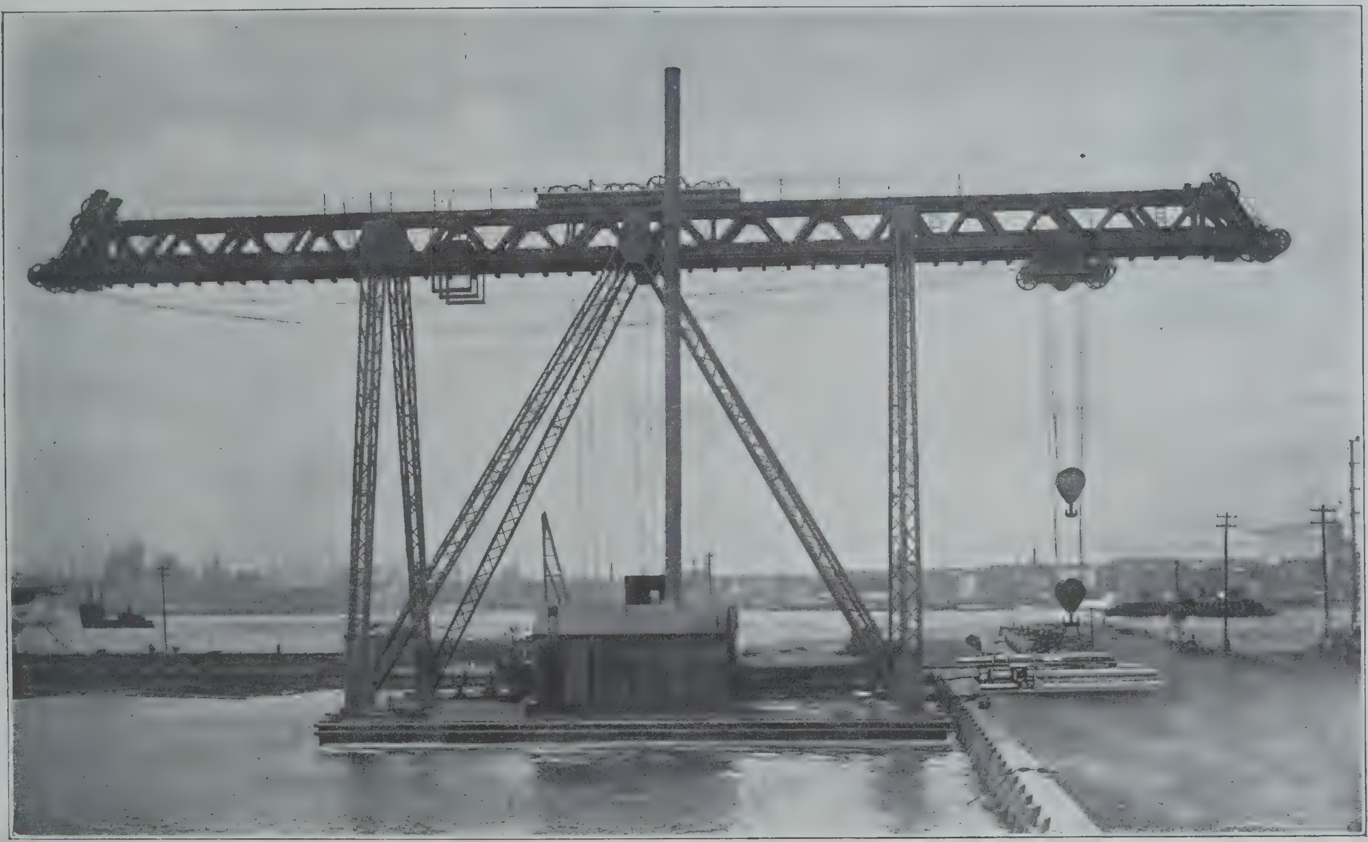


Fig. 1. "Hercules" Floating Crane at the New York Navy Yard, Lifting a Weight of 115 Tons.

As a matter of safety, should its cable break, it is necessary to have some device to keep the counterweight from going too far in either direction. The effect of turning a 250-ton weight loose in the hold of a pontoon can better be imagined than described. In Fig. 2 there is a shaft *S*, having an upper arm at *A* to which one end of the cable is attached. Should the cable break, arm *A* would be released, allowing the shaft to rotate and the shoes *B B* to drop upon the tracks, blocking the wheels against further motion. As a final precaution however, there are several spring buffers at each end of the pontoon, to assist in absorbing the shock, in case the counterweight should break away.

The hoisting apparatus is operated by four steam capstans, one for hoisting each crane hook and two for racking the trolley along the runway. The engines are geared to an intermediate driving shaft which in turn drives the different capstans through steam-operated friction clutches. These place the powerful mechanism within easy control of the operator and make quick handling possible. A pair of cables is used for each crane hook; that is, the tackle blocks and sheaves are all double, with two complete sets. The rated capacity of the crane is 100 gross tons, but it can easily handle a larger weight at the extreme ends of the arms, while at or near the center of the pontoon it can hoist a still greater weight.

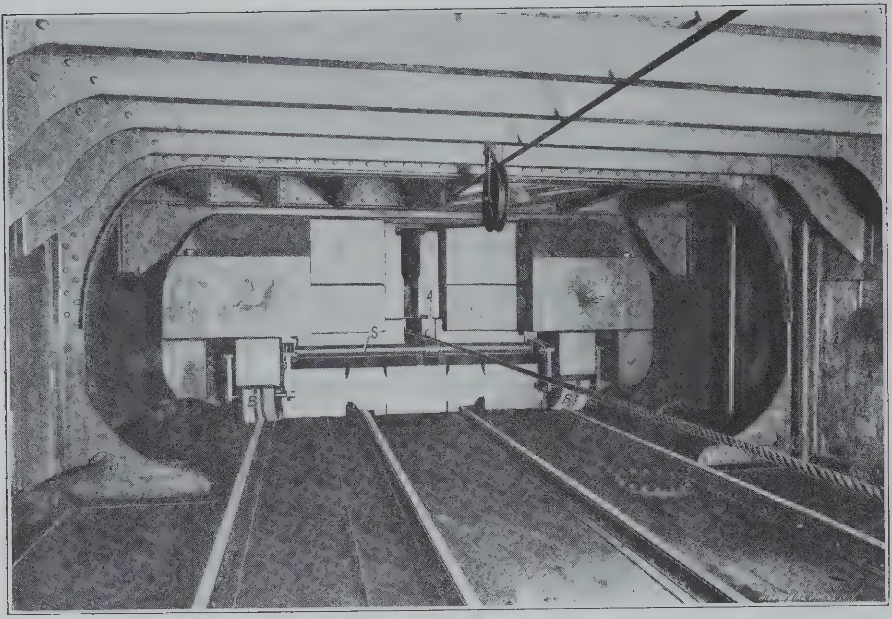


Fig. 2. Counterweight in Hull of Crane, weighing 250 Tons.

* * *

The pitting of discharge nozzles working under high heads, also the tips of cast iron propeller blades, is attributed by W. S. Smith in the *Journal of Electricity, Power and Gas* to the liberation of oxygen in a semi-nascent state because of reduced pressure. When air is absorbed by water the air and water become a solution instead of a mechanical mixture. When the pressure on the water is reduced the air separates in a condition to readily attack cast iron surfaces. Now it is well-known that unless a discharge nozzle is properly designed there will be portions of it not conforming to the natural stream lines. These portions will be areas of reduced pressure and here the pitting will occur. The same condition holds with the tips of propeller blades. The pitting is greatest at the tips where the disturbance of the water is greatest and the areas of reduced pressure exist. This seems to be a more reasonable explanation than attributing it to galvanic action. If galvanic action is the cause of propeller pitting it should consistently attack the whole surface instead of a limited area near the outer ends. To prevent the pitting of discharge nozzles Mr. Smith advises that they be carefully laid out to conform to the natural stream lines for the velocity at which they are expected to work. If the velocity is variable the nozzle should be designed for the highest velocity, since a nozzle that fills then, will continue to fill when the velocity is reduced. In regard to the construction, the writer of the article advises that the straight section of discharge nozzles be bushed with some processed metal on account of the difficulty of getting perfect iron castings.

STEAM ENGINE ECONOMY.

NOTES ON THE STEAM CONSUMPTION OF DIFFERENT TYPES OF ENGINES.

In 1858, Chief Engineer Isherwood, U. S. N., published his well-known volume, "Engineering Precedents," in which he gave the results of various tests that he had conducted upon steam machinery. His work was the beginning of what may be called experimental engineering, and for several years he was almost alone in the engineering profession in attaching greater importance to the results of the actual trials of steam engines and boilers than to the deductions of theory. In 1859, one year later, Prof. Rankine's classical treatise upon the steam engine was issued. This is one of the most complete and able works that has ever been written and is in extended use to-day, but his results are derived entirely from theoretical and ideal considerations. He only alludes very briefly to the actual interchange of heat between the cylinder and steam that occurs in the real engine, and the difference between the steam consumption of an engine determined by his formulas and by a feed-water test is very great.

Since this period, forty years ago, there have been many experimenters, notably through the efforts of the various colleges which have established engineering laboratories. The first of these was founded at the Massachusetts Institute of Technology, Boston, in 1875, where a Harris-Corliss engine was set up for experimental purposes. Of late years it has come to be the proper thing to have an economy test of all important plants, and there is now a great quantity of available information upon the subject of steam consumption. There is such a variety of information to be found that an experienced engineer can usually judge from it what the performance of an engine will be under varying conditions. This information has been published in the proceedings of the various societies, in technical papers and elsewhere, and much of it has been collected and arranged for ready reference in several of the later books upon the steam engine, such as "Peabody's Thermodynamics" and "Barrus' Engine Tests," published in this country, and the treatises by Ripper, Ewing and Perry in Great Britain.

Why Theory and Practice Differ.

As hinted above, the chief reason why the calculated steam consumption of the ideal engine falls far below the actual consumption of the real engine is because of the interchange of heat between the steam and the metal in the cylinder.

Saturated steam or steam as it is ordinarily supplied by a steam boiler, is at the critical point. If it comes in contact with a body colder than itself, part of the steam will condense; or if it comes in contact with a body at a higher temperature than itself, heat will be given to the steam by that body and any moisture present in the steam will be evaporated wholly or in part.

When the admission valve of a steam engine opens, the steam passes over the cooler surfaces of the ports and passages, and impinges against the cylinder heads, piston, etc. A large part of the steam is thus condensed, sometimes 50 per cent. or more, and usually 30 per cent., forming water before the point of cut-off is reached. After the point of cut-off the steam begins to expand, and condensation may possibly continue for a short time, through contact with the cylinder walls; but the action is reversed and the water begins to evaporate again as soon as the steam expands to a temperature lower than the temperature of the metal of the cylinder. This re-evaporation may be nearly or quite enough to change back into steam all the water that was formed by contact with the cylinder walls during the first part of the stroke, but there is, nevertheless, nearly always a great deal of water present in the steam at the point of release. This comes from the fact that when steam expands and its latent heat is converted into mechanical work, part of the steam condenses and adds to the water formed by the contact of the steam with the cylinder walls. About 20 per cent. of the steam present at cut-off would ordinarily be converted into moisture by this means. The final result is that when the exhaust valve opens the steam contains from 15 to 30 per cent. of moisture.

During exhaust this water is nearly or entirely evaporated and heat is abstracted from the cylinder walls in the process. When the exhaust valve closes, part of the exhaust steam is encased and is compressed in the clearance space so that this space does not have to be filled by the entering steam at admission. During compression the temperature and pressure of the encased steam rise and the surfaces of the cylinder head, piston, steam passages, and more or less of the circumferential surface of the cylinder become heated, which tends to reduce the initial condensation of the steam during the next stroke. If this heating effect were complete, it would effectually prevent condensation of the entering steam, but, as a matter of fact, there is never enough heat transferred from the compressed steam to the metallic walls of the clearance space to accomplish this result.

The actions just outlined are the chief reasons for the difference between the calculated water consumption of an ideal engine and the actual consumption of a real engine, and all of the effective means that have been employed to improve the economy of the steam engine have been to reduce the evil effects of cylinder condensation and re-evaporation.

Tables of Steam Consumption.

The accompanying tables show the actual steam consumption of different engines and pumps operating under different conditions. The last columns of the tables show the source from which the figures were obtained. They are all from records of tests and will be convenient for reference. It was not the purpose to select record-breaking results in making up the tables, but rather to indicate what may reasonably be expected from similar engines under good conditions. In comparing results with a table of this kind, however, it must be remembered that while an engine may run with a small steam consumption when it is in good condition and the various adjustments, the load, steam pressure, etc., are all favorable—such as is usually the case when a test is made—under other conditions this same engine may use steam extravagantly. We will therefore consider some of the most important things that affect the steam consumption, either for better or for worse. Of first importance, of course, is the condition of the engine as regards repair, adjustment, etc. The piston and valves must be tight, the valves properly set, there should be arrangements for draining water from the cylinder, and the full boiler pressure should be realized in the cylinder, as nearly as possible.

TABLE I. ACTUAL STEAM CONSUMPTION OF ENGINES OF DIFFERENT TYPES.

ENGINE.	Condensing or Non-condensing.	Dimensions.	H. P.	Steam Pressure.	Revolutions per min.	Steam per H.P. pr hr. lbs.	Authority or Book.
				Simple Engines.			
Agricultural Soc., England..	Non-cond.	....	5	....	....	75	Kent's Pocket Book.
Blower, S. S. Minneapolis....	“ “	2 cyl. 5 x 4	16.3	....	595	77	W. W. White.
Dynamo, “ “	“ “	2 cyl. 10.5 x 5	35.2	....	425	56	....
High-speed piston valve......	“ “	5 x 5	13.5	100	457	42.7	Stevens' Indicator-
Westinghouse	“ “	2 cyl. 5½ x 5	14.7	100	....	40 4	Westinghouse Catalog.
Single valve, automatic.....	“ “	8 x 12	32.3	82.4	308	31.2	Barrus' Engine Tests.
“ “ “	Cond.	18.5 x 30	204 6	74.5	129	27.2	“ “ “
Westinghouse	Non-cond.	2 cyl. 9½ x 9	64.6	100	....	33.5	Westinghouse Catalog.
“	“ “	2 cyl. 9½ x 9	20 6	100	....	34	“ “
Corliss at Mass. Inst. Tech ...	“ “	8 x 24	16	77	61	33.5	Peabody's Thermodynamics.
Corliss.........	“ “	23 x 60	305	72	75	27.8	Barrus' Engine Tests
Corliss......................	“ “	28.5 x 59.5	506 5	101	64 8	25.8	“ “ “
Corliss at Int. Exhibition, Cincinnati	“ “	18 x 48	120	96	76	23.9	J. W. Hill.
Corliss at Int. Exhibition, Cincinnati..................	Cond.	18 x 48	145	96	76	19.4	J. W. Hill.
Corliss	“	18 x 30	213	67	165	22	Barrus' Engine Tests.
				Compound Engines.			
Westinghouse	Non-cond.	14 and 24 x 14	90	100	....	25.2	C., B. & Q. R. R.
“	Cond.	14 and 24 x 14	100	100	....	18.6	Westinghouse Catalog.
Single valve, automatic.....	Non-cond,	11 and 19 x 11	109.7	136	296	22.9	Barrus' Engine Tests
“ “ “	“ “	12 and 20 x 12	230.5	128	296	22.5	“ “ “
“ “ “	Cond.	12 and 20 x 12	228	129	300	18.9	“ “ “
Corliss.	Non-cond.	17.5 and 28 x 48	487	136	99	21.6	“ “ “
Corliss	Cond.	16 and 32 x 48	383	127	75	14	“ “ “
Wheelock high ratio jacketed	“	18.4 and 48.5 x 48	595	159	76	13	F. W. Dean.
Leavitt Drainage Pumping, Boston, jacketed, reheater..	“	25.5 and 52 x 9 ft.	251.5	99	13.2	13.9	Peabody's Thermo.
Leavitt Pumping, Louisville, jacketed reheater.........	“	27.2 and 54 x 10 ft.	643.4	140	19	12.2	F. W. Dean.
Marine, “Rush”............	“	24 and 28 x 27	267	69	71	18.4	....
Marine, “Fusi Yane”........	“	27.4 and 50.3 x 33	371	57	56	21.2	Kennedy.
				Triple Engines.			
Marine, S. S. Brookline	“	23, 35 and 57 x 36	1136	154	93.6	15.5	Peabody's Thermo.
Marine, S. S. Iona	“	21.9, 34 and 57 x 39	645	165	61.6	13.4	“ “
Leavitt Pumping, Chestnut Hill...........	“	13.7, 24 4, and 39 x 72	575.7	175.7	50.6	11.2	E. F. Miller.
Allis Pumping, Milwaukee...	“	.. ..	574	122	20	11.8	R. C. Carpenter.
Sulzer, at Augsburg	“	11.3, 17.7 and 27.6 x 39 4	198	148	70	12 9	Peabody's Thermo.
				Steam Turbines.*			
De Laval, superheated steam.	“	350 H. P. nominal	352	207	750	13.94	Dean & Main.
“ “ “ “ .	“	“ “ “	196	202.4	747	15 53	“ “
“ “ saturated steam...	“	“ “ “	333	206.4	747	15.17	“ “
“ “ “ “ ...	“	“ “ “	118.9	201.5	751	16 40	“ “

* In these tests the stated horse power is the brake horse power.

Design of the Engine.

The steam consumption to be expected will depend very largely upon the design of the engine. Generally speaking, an engine with small clearance spaces is supposed to be more economical than one with large clearance, and while this may be true, it is not so much the clearance *spaces* as it is the clearance *surfaces* that affect the economy. If there is a large amount of cooling surface for the steam to come in contact with when it enters the cylinder, there will be a great deal of condensation and more steam will be required. If, however, the valves should set close to the ends of the cylinder, as in the Corliss engine, reducing the surfaces of the ports and passages, and leaving only the cylinder heads and piston and a small section of the cylinder walls to condense the steam, we should expect good economy, even if the clearance was considerable. Such a condition might exist if the piston did not travel the full length of the stroke, leaving quite a clearance space at each end, but still exposing quite a comparatively small extent of clearance surface.

The single valve automatic engine, while simple and compact, loses a little in economy, because of the long ports and of the fact that the cool exhaust steam must pass through the same passages and the same valve through which the hot steam enters. The single valve, also, does not give as good steam distribution as when two or four valves are employed, with two eccentrics. The main characteristic of the single valve is, that the earlier in the stroke it cuts off the steam, the greater will be the compression, and at very early cut-off the compression becomes excessive, so that it is possible to run the engine at this point and thus realize the full benefits of the expansion of steam. The compression, however, warms up the clearance surfaces and so is not a bad feature for this type of engine.

TABLE II. DIRECT-ACTING PUMPS.

PUMP.	Steam Cylinder Dimensions.	Horse-Power.	Steam Pressure	Strokes per min.	Steam per H P. per hour.	Authority.
Duplex, Mass. Inst. Technology......	16 x 12	6.78	58.5	99	125	Peabody's Thermo.
Duplex, Mass. Inst. Technology......	16 x 12	41.20	46.5	180	67	Peabody's Thermo.
Duplex, S. S. Minneapolis.........	12 x 12	8.8	....	22	91	....
Duplex, S. S. Minneapolis...... ..	12 x 12	1.6	...	5.2	243	....
Single, Pressure ...	14 x 13	3½	....	.....	100	H. E. Walton, in MACHINERY.
Duplex, " ...	10 x 10	7	....	.....	140	H. E. Walton, in MACHINERY.
Single, Air Pump..	5½ x 7	¾	....	... .	190	H. E. Walton, in MACHINERY.

Expansive Use of Steam.

The most important principle in steam engine economy is that steam must be used expansively. If the greatest possible power is to be developed for a given expenditure of steam and coal, the supply of steam must be cut off from a steam engine cylinder at some point before the end of the stroke, and the steam allowed to do its work during the balance of the stroke by virtue of its expansive force, due to its latent heat.

In the direct-acting steam pump the expansive force of the steam is not utilized, and the wastefulness of such pumps is clearly shown in the second table. In a pump the steam is admitted to the steam cylinder at the beginning of the stroke and continues to act against the piston at full boiler pressure until it is cut off from the cylinder at the end of the stroke. At that point the exhaust valve opens, and the steam which fills the entire cylinder, and is at boiler pressure, is blown out into the atmosphere.

In the case of the steam engine, the steam is allowed to expand to a pressure at or near atmospheric pressure before it is discharged to the atmosphere. If it be supposed that it expanded to four times its original volume, the cut-off taking place at ¼ stroke, there would be only one-quarter as much steam used per stroke as in the case of the steam pump, supposing the two cylinders to be of the same size. It can be shown by comparing the theoretical indicator cards for the two cases, that the power developed by the engine would be about one-half the power of the pump. In other words, the pump would develop double the power, but with four times the steam. This affords a crude illustration of the fact that steam economy depends in a large measure upon using the steam expansively.

No rules can be given telling how far to carry the expansion, in any case. It is generally considered that the best results, with simple non-condensing engines, are obtained when the cut-off is at about one-third stroke; and with simple condensing engines, with the cut-off at from one-sixth to one-quarter stroke. Varying degrees of expansion are used with compound engines, the point of cut-off in the high-pressure cylinder being adjusted to give from 12 to 20 expansions in both cylinders.

Variation in the Point of Cut-off.

It is not economical to operate an engine when it is overloaded, or, on the other hand, when it is too large for the work it has to do, because the point of cut-off will come either too late or too early in the stroke for the economical use of the steam. If too early, there will be an increased loss from cylinder condensation, and if too late, the expansion of the steam will not be so complete as it should be. When an engine is running under these conditions it is better, if possible, to change the steam pressure or else the speed of the engine so as to allow the point of cut-off to be more nearly at its correct position.

The extent of the losses due to a variation in the point of cut-off is shown by the results of tests made by George H. Barrus and recorded by him in his "Engine Tests." Tests were made upon Corliss engines of medium or large size and he found that the amount of condensation and leakage, taken together up to the point of cut-off, was 60 per cent. of the steam consumed when the cut-off wat at 5 per cent. of the stroke; 45 per cent. with the cut-off at 10 per cent. of the stroke; 35 per cent. with the cut-off at 15 per cent. of the stroke; 30 per cent. with the cut-off at 20 per cent.; 20 per cent. with the cut-off at 30 per cent., and 15 per cent. with the cut-off at 40 per cent.

While the percentage of losses from these sources is thus found to decrease as the point of cut-off grows later, the total condensation may be as much, or more, with a late cut-off as with an early cut-off, owing to the larger quantity of steam used when the cut-off is late in the stroke. Of the two, it is better to operate an engine with too heavy a load than with too light a load, as far as the consumption of steam is concerned.

Running Condensing.

The safest and surest way of improving the operation of an ~~overloaded~~ engine is to add a condenser. The gain in economy resulting from the use of a condenser may be assumed to be from 20 to 25 per cent. when account is taken of the steam consumption of the engine only. When measured by the quantity of coal burned under the boiler the gain will be less than this, because it is not possible to heat the feed water to so high a temperature by means of the exhaust steam when a condenser is used as when the engine is running non-condensing.

Speed of an Engine.

It has been demonstrated by experiment that when the ~~rotative~~ speed of an engine is increased, the quantity of steam used per horse power per hour will decrease. This is because there is less time for the transfer of heat between the cylinder walls and the steam and also for the loss of heat through radiation. Tests made upon a Willans non-condensing engine, with steam at 90 pounds pressure, show a decrease in steam consumption of from 27 to 24 pounds as the speed increased from 122 to 400 revolutions. A great many tests of a similar character have been made ~~by Mr. Willans~~ confirming these figures. The fact that many high-speed engines are not as economical as engines of slower speed, is no indication of the effect of speed on economy. The losses in high-speed engines are due to other causes and would be greater were the engines to run at slower speed.

High-pressure Steam and Compounding.

Both theory and practice show that increased economy in the use of steam can be obtained by using higher steam pressures. This is because there is more heat in high-pressure steam available for doing work, in proportion to the amount of heat required to generate the steam, than is the case with low-pressure steam. Also there is a smaller percentage of the steam used in doing useless work. Part of the power of an engine is absorbed in overcoming friction and in moving the piston against the atmospheric pressure of 14.7 pounds. These two factors are constant quantities, being practically the same, whether the engine is developing a large or small amount of work. With high-pressure steam, therefore, a smaller percentage of the total pressure is required to do this useless work.

There is no gain, however, in using extremely high-pressure steam in a single cylinder engine, because of the loss from condensation due to the extreme ranges of temperature that would result. When very high pressures are to be used, compounding must be resorted to in order to keep the temperature ranges in each cylinder within reasonable limits.

In Peabody's "Thermodynamics" is the following statement of the steam pressures that may be used with good results and also of the gain that may be expected from compounding, which latter allows the use of higher pressures:

"For a simple non-condensing engine the steam pressure may be 100 to 115 pounds above the atmosphere, and for a compound engine the pressure may be 150 pounds, while for a triple engine the pressure may be 175 pounds or possibly somewhat more. The gain from compounding will be 20 to 30 per cent., and the gain from using a triple instead of a compound engine will be 5 per cent., or perhaps a little more. For simple condensing engines there is no advantage in using more than 80 pounds steam pressure, while compound condensing engines may advantageously have the pressure raised to 135 pounds above the atmosphere. The gain from higher steam pressure and compounding will be 25 to 30 per cent. The best pressure for triple engines cannot now be determined from experiments; it is, however, doubtful if there is any advantage in using more than 175 pounds above the atmosphere. Such a further increase of pressure and the use of a triple instead of a compound engine may be expected to give 8 or 10 per cent. better economy."

The above explanation and comments are intended to give a general idea of some of the principles of steam engine economy. The fact that the steam consumption of an engine is affected by the clearance surfaces, the speed, the pressure of the steam, etc., shows that no table can be given which will be an absolute guide in determining what the steam consumption of an engine should be. In this, as in nearly everything else, experience and study alone can help one in arriving at correct conclusions. There are various other expedients used to improve the economy of steam engines, such as steam jackets, re-heating receivers, superheating the steam, etc. Of these the latter is probably the most important and during the next few years will probably be introduced in many of our best steam plants. The results obtained will be awaited with much interest.

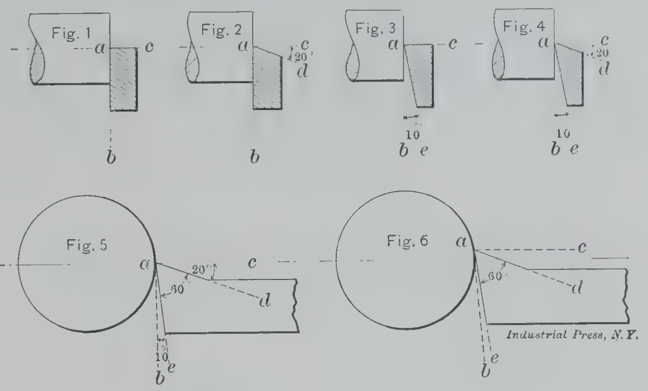
* * *

THE ELEMENTS OF CUTTING TOOL ACTION.

Sketch No. 1 represents an end view of a piece of tool steel cut from a bar and applied to the work. The left face of the tool coincides with the end of the cylinder on the line *a—b*, and it is evident that no amount of pressure in the direction *c—a* will make the tool cut. If the top face of the tool is cut down so as to present the angle *d—a—c* (sketch No. 2), the left face remaining the same as before, the conditions then obtained still exist and the tool will not cut. If, on the other hand, we cut away the left face so as to present the angle *b—a—c* (sketch No. 3), it hardly needs demonstration to show that although the tool will not cut cleanly, it can be made to remove metal by a scraping action.

By cutting away the tool on both the top and left faces, we present to the work a shape shown in sketch No. 4; and it is clear that our tool will not only cut, but will do it in a manner somewhat similar to the action of a knife in a piece of wood.

As a result of the above experiments, it is demonstrated that cutting away the face adjacent is absolutely essential, and the more the top face can be beveled down, the easier will be the cutting action. From this we conclude that the angle *b—a—c* should not be greater than is necessary to allow the tool to enter the work; so the angle *d—a—c* can be made as large as is possible without a dangerous reduction of the edge of the tool. Practical work shows that the greater the angle *d—a—c*, the larger will be the spiral into which the chip is rolled, showing less bending of the chip after cutting than would be the case with a smaller angle. Experiment has shown that more power is consumed in bending the chip than in the actual cutting; therefore, the greater the angle *d—a—c*, the less the power consumed, and owing to the clean cutting, the better the surface produced. The angle below the tool, *b—a—e*, I call the angle of clearance; the angle above the tool, *d—a—c*, the angle of rake; the angle *d—a—e*, the solid or cutting angle.



Industrial Press, N. Y.

Elements of Cutting Tool Action.

It will be noticed that the line *a——c* is normal to the work surface at the cutting point, and is at right angles to *a——b*; therefore the sum of the three angles is always 90 degrees. The angle of clearance should be a minimum and not exceed 10 degrees; the angle of rake should be a maximum and not less than 20 degrees; the solid or cutting angle, with the rake and clearance values given above, would be 60 degrees. These values are approximate only, and are varied to suit the metal being cut, the grade of steel in the tool, and the speed of cutting.

In Fig. 5 the tool is in operation on a surface of revolution instead of on a flat surface, but when set so as to advance along a line passing through the axis of rotation the action is the same as when the tool is applied to a flat surface.

Any change in setting will change the values of the rake and clearance angles only, as it is evident the solid or cutting angle cannot be changed by moving the tool. In Fig. 6 can be seen the effect of setting a tool too high. The tool and work are the same as in Fig. 5, but, by setting the tool above the center, the angle of clearance is decreased and that of rake correspondingly increased. In this position the tool will cut, but as the tool advances the angle of clearance is lessened until the line *a——b* coincides with the face *a——e* of the tool, when clearance disappears and the tool ceases to cut.

Setting the tool below the center will result in increased clearance and decreased rake. Advancing the tool will increase the angle of clearance, thereby weakening the tool, and will decrease the angle of rake, changing the cutting action to scraping and finally to rubbing, when the tool will cease to remove metal.

The diamond point tool has the rake of the side tool combined with that of the round nosed tool, or, in more technical terms, it has side rake and front rake. When used for roughing cuts, it should have more side rake than front rake, but when used for finishing, the reverse is true, as there is little metal to be removed and the chip is bent less by allowing it to come well to the front.—*From paper read by F. W. Turner before the N. E. Asso. of Teachers of Metal Work.*

* * *

Work has been begun upon the construction of a steel road way on Murray Street, New York City, which will extend from Church St. to Broadway. This road is made of two parallel lines of 12-inch by 3½-inch steel channels laid, flange downward, 5′ 6″ apart, c. to c., on a bed of broken stone. The web of these channels, which in this case forms the top, has on each edge a slight rounding flange to keep the wheels of the vehicles on the tracks.

SPECIFICATIONS FOR ELECTRIC MOTORS FOR OPERATING NAVY YARD MACHINERY.

The Bureau of Construction and Repair of the U. S. Navy Department in January, 1902, issued the following specifications for electric motors for operating navy yard machinery. Some adverse criticism, we learn, has been directed against certain features, and we have been requested to publish the specifications for the benefit of machine tool builders and others having to do with electric motor equipment. We have submitted them to a number of the leading electrical manufacturing concerns, but so far have received no unfavorable comments. The Crocker Wheeler Co. commend them, saying that while they are closely drawn, as are all Government specifications, they require nothing more than can be met easily by the better class of electrical manufacturers. The Bullock Electric Manufacturing Co. merely suggested that the efficiencies should be determined according to the rule of the American Institute of Electrical Engineers:

1. Motors to be direct current of three types:
   (a) Open.
   (b) Semi-enclosed.
   (c) Enclosed.

(a) Open type motors may be of any desired design such that the brushes and commutator are readily accessible and all parts free to good ventilation.

(b) Semi-enclosed motors are to be of such design that all parts are completely protected from external mechanical injury, and all openings into the interior of the motor are to be covered with perforated metal or wire mesh covers arranged to secure the best possible ventilation and by their removal allow access to the commutator and brushes.

(c) Enclosed motors are to be entirely enclosed and dust-proof, but provided with removable covers to allow access to commutator and brushes.

Ordinary open type motors provided with separate housings will not be accepted as enclosed motors.

2. Armatures must be of the iron clad type and have form wound coils, easily removable for repair, except that motors of less than 7 H. P. may have hand wound armatures if desired.

3. Commutators must be of pure hard drawn or drop forged copper. Cast segments will not be accepted. Segments to be insulated with mica of such hardness as to wear even with the copper.

4. Brushes are to be of carbon and not to carry more than 35 amperes per square inch at full load. The brush holder springs shall not be depended upon to carry current. In motors of 5 H. P. and above, brush holders are to be separately adjustable for tension without tools, and simultaneously adjustable for position. In motors below 5 H. P. these adjustments are not required. Brush holders to be of such design that by very slight changes in the relative position of their parts the rotation of the armature may be in either direction with equal satisfaction; also the angle of the brush to the commutator not to change as the brush wears down.

5. Bearings to be lubricated by self-oiling rings; to have oil reservoirs of ample capacity provided with means for visually determining the amount of oil in same and with means for drawing off oil. Satisfactory means to be provided to prevent oil from running along the shaft on being spilled.

6. A name plate to be attached to the motor frame stamped with the rated H. P. volts, amperes and speed, and sufficient data to permanently identify the motor in the records of the manufacturer.

7. Di-electric strength of insulation is to be tested in accordance with the rules of the American Institute of Electrical Engineers.

8. Open motors must run from no load to full load; semi-enclosed motors from no load to 10 per cent. overload; and enclosed motors from no load to 25 per cent. overload, without sparking and without shifting the brushes. Motors to run at all rated loads and speeds without vibration and without undue noise.

9. Motors are to be tested at the works of the maker in the presence of an inspector and are to run for a continuous period of 6 hours at full rated load, speed and voltage, without the temperature rise above the surrounding air exceeding the following limits for the different types of motors:

Part.	Open Motors.	Semi-enclosed.	Entirely Enclosed
Field coils by resistance...........	50	55	55
Armature, commutator, and all other parts by thermometer...........	45	50	55

All rises are in centigrade degrees. The temperature rise of the field coils is to be measured by the resistance method according to the rules of the American Institute of Electrical Engineers. All other temperatures are to be measured by thermometer. Temperature rise of bearings in no case to exceed 40 degrees. Semi-enclosed and enclosed motors are to be run with all their covers on.

During the 6-hour heat run no adjustment of brushes, cleaning or dressing of commutator, or similar attentions are to be performed on the motor, but after being once put in proper running condition it must complete a satisfactory run without further attention.

10. Motors are to stand the following overloads:

Type.	Overload for One Hour.	Overload for Three Minutes.
Open	25 per cent.	40 per cent.
Semi-enclosed	35 per cent.	60 per cent.
Enclosed	50 per cent.	100 per cent.

The one-hour overload is to be run without injurious sparking, or heating of the commutator more than 15 deg. C. above the allowed rise for full load for 6 hours, and may be started with the motor cold if desired. The three-minute overload is to be run without injurious heating, or flashing over or burning of the commutator or brushes, and is to be made within 45 minutes of the end of the six-hour heat run.

11. The full load efficiencies of motors to be at least as follows:

H P.	Open.	Enclosed and Semi-enclosed
2	78 per cent.	75 per cent.
5	83 per cent.	80 per cent.
10	86 per cent.	84 per cent.
15	87 per cent.	85 per cent.
25	89 per cent.	87 per cent.
40	90 per cent.	88 per cent.

Intermediate sizes to have proportionate efficiencies. Efficiencies to be taken with motor hot at end of heat run.

12. Controlling panels, unless otherwise specified, to consist of an enameled slate panel containing the following:

Line switch and enclosed non-arcing fuses.
Starting rheostat with automatic no-voltage release.
Adjustable overload circuit breaker.

For motors above 10 H. P., a single pole circuit breaker of approved construction entirely separate from the starting arm is to be used. 10 H. P. and under, may, if desired by the contractor, have the circuit-breaking device constructed as an interlocking part of the starting mechanism, but having the arc rupturing parts entirely separate from the starting arm. In no case will an overload device which operates by short circuiting the no-voltage release magnet be accepted. On any panel a double pole circuit breaker having each side independent as regards closing, may be used, and the line switch omitted, at the option of the contractor.

The resistance coils are to be mounted on the back of the panel and are to be entirely enclosed and dust proof.

13. All material and workmanship to be of the best quality and any defect due to defective design, material or workmanship, which may develop during the first year after delivery, to be made good by and at the expense of the contractor.

14. Bidders are to state in their proposals the manufacture of the motors and controlling panels they propose to furnish, and are to submit drawings, prints, photographs, or other illustrations from which a clear idea may be obtained as to their general construction. If bidders can guarantee their machines to give in any particular a better performance than required by the specifications, such fact should be stated in the bid.

* * *

It is estimated that in the whole world more than 1,000,000 telegraphic messages are sent each day. The total length of the conducting wires would be sufficient to encircle the earth 150 times at the equator.

ENGINEERING REVIEW.

A SYNOPSIS OF CURRENT TECHNICAL LITERATURE.

APPLICATION OF EXPANSION TO RAILWAY WRECKING.

The Engineer, November 1, 1902. p. 730.

One of the most important things which must always be taken into consideration in engineering work is the expansion and contraction of materials under the action of heat. Who has not noticed the gap between the ends of the rails on a railway line? In winter these gaps will be over a quarter of an inch wide, while on a hot day in summer, they will be almost closed. During one of the wars in South America, one of the belligerents conceived a unique method of train-wrecking. During the night he drove steel wedges into these gaps for a considerable distance. The heat of the sun next day caused the rails to expand, and they twisted themselves clean out of the chairs which clamped them to the sleepers, and the railway was rendered completely useless for traffic.

SOME MACHINE DESIGN IDEAS BY PROF. SWEET.

American Machinist, November 6, 1902, p. 1586.

Regarding the development of the engine lathe as a machine tool, no one seemed to dare to make any radical improvements all at once. First it was "new pattern heavy lathe," then some one thought to make the main bearings larger and longer, and advertised the fact. The next man followed, doing the best thing he could by making it larger and the worst thing he could do, at the same time, by making it longer. In the next twenty-five, or it may be only ten years, someone will have the courage to make his lathe main bearing 6 inches big and 6 inches short.

When someone makes the milling machine with a spindle as large as the cutter it is to drive, and a gear in proportion, and a cutter supported close up to its sides; or a traversing machine for carrying end mills with a 12-inch spindle and a 12-inch inserted tooth cutter with blades made of 1½-inch steel, it will begin to look like the milling machine doing the work of the planer.

STEEL DRIVING WHEEL CENTERS CAST WITH SOLID RIMS.

American Engineer and Railroad Journal, November, 1902. p. 349.

The general practice in steel foundries, is to cast steel locomotive driving wheel centers with the rims cut in several places in the periphery to allow for contraction in the mold and shrinkage stresses. The ends of the rim sections are afterwards slotted out in the machine shop and wedges driven in, making the rim practically solid so far as resisting the compression of the tire. It is obvious, however, that it would be preferable to have steel centers cast with the rims entire; the wheel center would be stronger and machine work and fitting would be saved.

Mr. S. S. Prince, Jr., superintendent motive power of the P. & R. R.R. has designed a steel wheel center to be cast with uncut rims. To provide for the shrinkage of the casting in the mold, the spaces between the spokes are packed with sawdust, which offers an elastic resistance to the contracting forces. To make the molder's work simpler the pattern is made with the draft all in one direction, the draft being toward the outer face of the wheel center, so this side is molded downward.

METHOD OF TREATING BUFFINGS.

Aluminum World. 1902.

In many places where copper, brass, or nickel are buffed with cotton buffing wheels, it has been a problem to know what to do with the waste products which fly off. They were formerly thrown away, but in the present economical age are sources of some revenue. If allowed to remain in heaps they not only require a large amount of space, but the danger of spontaneous combustion is quite a serious one.

Erwin S. Sperry says that one manufacturer has solved the problem, as far as he himself is concerned, in a manner somewhat out of the beaten path. He is a brass manufacturer, and makes his brass in crucible furnaces. Every night after the furnaces have been dumped, the ashes removed, and the grate bars replaced, he fills the pot holes with buffings and allows the combustible matter to burn off. The fire brick walls of the furnaces usually remain red hot for some time after the fires have been dumped. This not only serves to ignite the buffings but aids the combustion as well. The ashes, consisting of the metal in a finely divided condition, and, of course, the products of combustion, drop down into the pit. They are compact, however, and can be put into barrels without any danger of spontaneous combustion. The ashes are valued according to their content of copper and are always a marketable product. A process of this kind for treating buffings is an excellent method and is very economical as it utilizes the waste heat of the furnaces.

ELECTRIC POWER IN ROLLING MILLS.

Western Electrician, November 1, 190, p. 307.

Electric motors are now used in many of the large rolling mills of Europe, where their operation has proved very successful. The Nordisk mills at Stockholm have been using electric power for some time past. Here a large plate-rolling mill and a smaller mill are both driven by the same motor. The large mill has a set of rolls 28 inches in diameter, with table lengths of four and six feet. In this case it was not found practicable to drive the rolls directly by motors, but instead a mechanical device is used for driving and reversing the movement, and a friction clutch gives a progressive movement and avoids shocks. The plant is driven by a direct-current motor of 350 horse power working at 320 revolutions per minute. The motor is belted by wire rope to a 30-ton flywheel, which runs at 150 revolutions. The flywheel is mounted on the main shaft, from which the two rolling mills and the mechanism of the tables are operated by gearing. A friction clutch is used to throw off the smaller mill and allow the larger to work alone. This plant has been running for some time past and this method has many advantages over the old one.

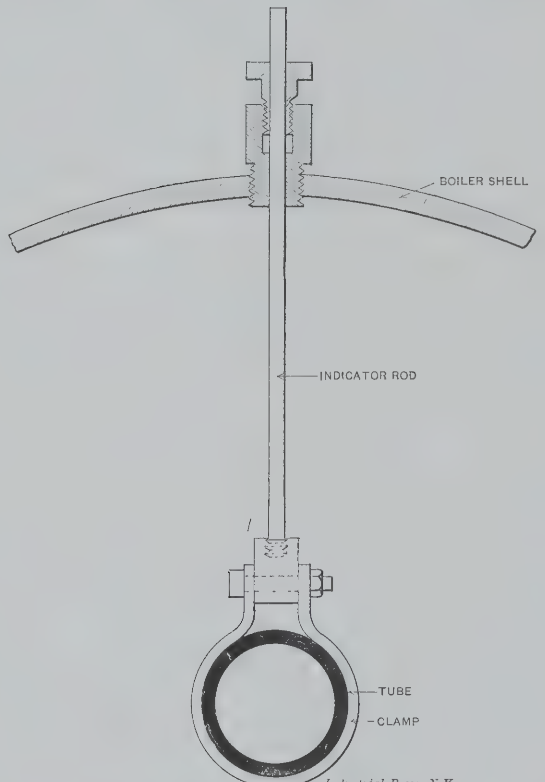
Another application of electric motors to operate steel-plate mills is found at the Antwerp Steel Works, where a plant has been lately installed. The current is furnished from the new central station erected by the Antwerp Electric Company near the city—a large plant which is to produce 25,000 horse power from blast-furnace gas. This company will furnish current for the different industries in and near Antwerp, and one of the first is the Antwerp Steel Works, for which are used two generating sets giving three-phase current. Westinghouse alternators are used here, giving 1,500 horse power each at 2,200 volts. At the steel works both high and low tension are used for the motors. A number of small motors drive different apparatus, such as traveling cranes, shears, small rolls, etc., and these all take current at 200 volts, which is fed from transformers. The large rolls, however, use the main current at 2,200 volts without transformation, employing non-synchronous motors which work at variable speed. One of the largest rolls, turning at 70 revolutions, and having a 30-ton flywheel, is operated by belt from a 325-horse power motor, and a second roll, the heaviest in the plant, has a 450-horse power motor. The two motors are lodged in the same cabin, placed between the two mills. The controlling apparatus is mounted on an elevated platform, where the operator has a view over the whole shop.

LONG BOILER TUBES DO NOT VIBRATE.

Locomotive Engineering, November, 1902, p. 484.

One of the objections urged against the use of long tubes in locomotive boilers, was that they would tend to vibrate when the engine is working, and thereby loosen themselves in the tube sheet. So when some of the fast Prairie type (2-6-2) passenger locomotives on the Lake Shore & Michigan Southern R. R. began to give trouble because of leaky tubes, it was suspected that it might be caused by the length of the tubes, which were 19 feet 6 inches long and 2¼ inches diameter. To determine the facts in the case, Mr. S. K. Dickerson, the master mechanic at Collinwood, O., made an experiment which will be of interest.

Acting under instructions, Mr. B. F. Kuhn, general foreman, made the experiment. One of the top tubes was selected and over its center a hole was drilled in the boiler shell, into which a plug with stuffing-box was screwed. The tube itself was tightly grasped by a band of iron ¾-inch wide by ⅛-inch thick, the ends of which were bolted together with a filler between, much as an air brake hose clip clamps the rubber to the nipple. Into the small filling piece was tapped the end of an iron rod, which passed out through the plug with the stuffing-box in the boiler shell. The end of the rod projected above the top of the stuffing box, about two inches, and when in normal position with steam on the engine, a gage was made to correspond with the top of the projecting rod. Any vibration or deflection of the tube, would therefore be at once visible in the altered height of the projecting rod end. The tube itself being 19 feet 6 inches long, had, of course, a slight normal deflection, due to its weight, but when the engine was working hard, the indicator rod was observed to sink down 3-16 inch, and to remain steadily in that position without vibration or tremor of any kind. As the engine was worked lighter, the indicator rod rose correspondingly, but in no case indicated any vibration of the tube in the boiler. When a stop was made at a station the indicator rod came up to normal. The stuffing box, all through the experiments, was adjusted loosely enough to leak steam so that the indicator rod could not possibly act as a stay or steady-rest for the tube. The tube did not vibrate, but it sagged down in the center the harder the engine was worked, and tended to straighten itself out when the engine was worked lighter or came to rest.



Industrial Press, N.Y.

Fig. 1. Test for Boiler Tube Vibration.

The explanation of this action which the Lake Shore people give is that the tube naturally sags slightly in the center on account of its weight, and when the engine worked hard, a greater quantity of heat passed into the tube in order to generate the larger volume of steam needed for climbing a grade or making up time, as the case may be. This greater amount of heat expanded the tube, and it being fixed at both ends and slightly sagged in the center, sagged still more, under the action of heat as indicated by the lowering of the top of the rod. They argue that had the tube been originally cambered, the indicator rod would have been pushed up when the engine was worked hard. They account for the tubes leaking by pointing to the greater work done by the tube in transmitting to the water the extra heat when the fire was forced, and the general "punishment" sustained by all tubes when heavy work is being done.

THE ADAPTABILITY OF THE TURBINE TO SUPERHEATED STEAM.

Detroit Meeting of the American Street Railway Association, October 8-10, 1902.

It is a clearly defined principle of thermodynamics that the greater the range between the initial and final temperatures of the working fluid employed in a heat motor, the greater its efficiency. That is in the equation $E = \frac{T_1 - T_2}{T_1}$, in which

E = efficiency,
T_1 = absolute initial temperature,
T_2 = absolute final temperature.

In the case of the steam engine the absolute initial temperature is the temperature of the steam at boiler pressure + 460 degrees, Fahrenheit scale. For a boiler pressure of 120 pounds gage this means a temperature of about $350 + 460 = 810$ degrees, or T_1. If the exhaust has a back pressure of, say 2 pounds gage, the final temperature is about $219 + 460 = 679$ degrees F., or T_2. Therefore $T_1 - T_2 \div T_1 = 810 - 679 \div 810 =$ 16.2 per cent. theoretical efficiency, nearly.

To secure a greater range of temperature in the steam engine without increasing the boiler pressure, it is necessary to superheat the steam; that is, to impart to it a greater temperature than it will acquire while in contact with the water from which it was evaporated. Superheated steam greatly increases steam engine economy for two reasons: The first is that the temperature range is increased, and the second is that the losses from internal condensation are reduced because superheated steam does not yield its heat so readily to the cylinder walls. But there are serious difficulties arising from the use of superheated steam in the reciprocating engine. It is difficult to find a lubricant that will stand the high temperature and at all times prevent abrasion of the working surfaces. The high temperature also tends to change the shape of the valves and thereby induce leakage. So in the superheated steam engine the two serious evils to be overcome are abrasion of the working surfaces and the leakage caused by badly fitting valves and pistons. It is quite evident that this evil rapidly increases with an increase of temperature and that there is soon reached a temperature above which it is not practicable to go. The superheated steam engines of the New York Edison plant use steam at a temperature of about 575 degrees, and while there are European engines that employ temperatures still higher, this may be regarded as about the practical limit.

With the steam turbine, however, the range of superheating is limited practically only by the limit of the superheater. There are no rubbing surfaces so that the matter of lubrication does not need to be considered, nor the effect of high temperature on closely fitted surfaces since they are not present in the steam turbine.

At the Detroit meeting of the American Street Railway Association a paper was read on the steam turbine, and in the discussion following, Mr. C. O. Mailloux of New York said in reference to the possibility of using superheated steam in the turbine:

"I have had occasion to design large plants in which I have seriously considered the question of using superheated steam, and found, much to my sorrow, that in many of the engines, as at present constructed, there is a limit to the temperature that can be allowed in high-pressure steam. When you reach very high temperatures lubrication becomes almost impossible. With a steam turbine, on the contrary, there is no limit to the temperature of superheating that you may attain. Its only limit is the melting point of the material of which the engine is made. I see no reason why you could not run a steam turbine at a point where it would be cherry red, and glow in the dark, if there was any advantage in it. Of course, we all know there is a great advantage in superheating steam."

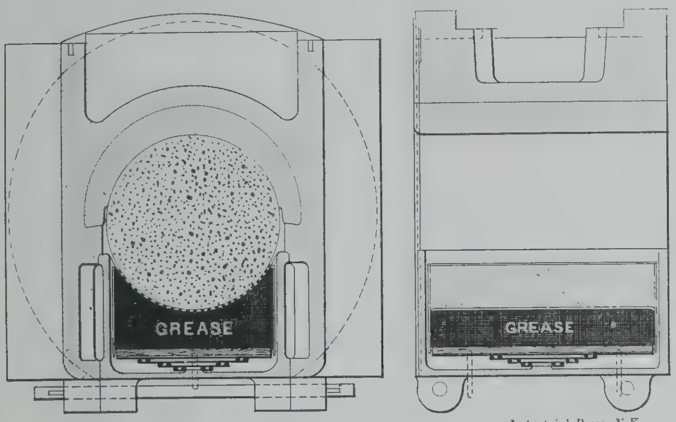
GREASE LUBRICATION OF LOCOMOTIVE DRIVING BOXES.

American Engineer and Railroad Journal, November, 1902. p. 356.

One of the most annoying and troublesome difficulties of railroad operation, and at the same time one of the most mysterious, is the occurrence of hot boxes. They are often produced by well known causes, and perhaps oftener by causes which are not known or understood. The latter are apparently not to be guarded against by usual methods. It is reasonable to suppose that a properly lubricated journal will not heat and that when one does heat it is because the surfaces for some reason become dry. Locomotive driving boxes present a difficult problem in this respect, and in spite of all that has been done to avoid it they often give trouble and sometimes with serious results. Many devices have been tried for relief and yet hot journals continue. There seems to be no sure way of lubricating driving boxes with oil to insure freedom from heating.

If grease can be substituted for oil in this case, applied at the bottom of the journal, with no openings at the top of the bearing, there is reason to hope that relief may be found.

Fourteen locomotives of the D. L. & W. R.R. have been equipped with hard grease lubricators for the driving axles, substantially as shown in Fig. 2. The principle is essentially the same as that of grease oil cups for ordinary bearings, but the application to locomotive driving axles is a decided novelty, and one that is a pronounced success. The grease is molded into cakes shaped to fit the cellars and with the upper surfaces concaved to fit the journals. The upper surface is faced with a perforated plate, through which the grease is forced by a spring bearing against a follower plate on the under side. This follower plate is made an easy fit in the cellar so the spring is free to press the grease cake against the wheel. An indicator pin is attached to the bottom of the follower and projects through the bottom of the box to show the amount of grease left of the cake. When the end of the indicator wire is flush with the bottom of the cellar, there is still ¾ inch of grease in the cake in the shallowest part.



Industrial Press, N. Y.

Fig. 2. Hard Grease Lubrication for Locomotive Driving Boxes.

As regards the economy of the innovation, one 4-wheel connected locomotive is quoted that has had an average of 9 pounds 8 ounces applied to each box, and, according to the consumption to date this amount should suffice for 50,000 miles with enough left for 10,000 miles which is the margin provided for safety. This means that the cost of the driving axle lubrication, is only 4.8 cents per 1,000 miles as against 58 cents for oil, and there have been no hot boxes. The same device has been applied to truck axles, and there seems to be no good reason why it cannot with equal profit be applied to car axles. This improvement in axle lubrication has been worked out under the direction of A. G. Elvin, master mechanic of the D. L. & W. R.R. shops at Scranton, Pa.

FLY-WHEEL AND BOILER EXPLOSIONS COMPARED.

Monthly Bulletin of the Fidelity and Casualty Co., November, 1902. P. 176.

The influences that bring about fly-wheel explosions are in some respects very similar to those that produce boiler explosions, says Wm. H. Boehm. In the case of boilers, steam exerts a radial force acting on the shell of the boiler, and whenever the steam pressure, either through accident or negligence, increases sufficiently, the radial force bursts the shell with great violence. In the case of fly-wheels, speed exerts a radial force acting on the rim of the wheel, and whenever the speed, either through accident or negligence, increases sufficiently, the radial force bursts the rim with great violence. In both cases the direction of the forces is the same, since they both act from the center toward the circumference. In the case of boilers steam exerts the radial force that produces an explosion. In the case of fly-wheels speed exerts the radial (centrifugal) force that produces an explosion. These influences are widely dissimilar in other respects.

In the case of boilers the force tending to burst the shell increases directly with the steam pressure. Doubling the steam pressure, for example, doubles the force acting on the shell. In the case of fly-wheels the force tending to burst the rim increases with the square of the speed. Doubling the speed, for example, quadruples the force acting on the rim. In the case of boilers their strength may be increased by increasing the thickness of the shell. If we double the thickness of the shell, for example, we double the strength of the boiler. In the case of fly-wheels increasing the thickness of the rim does not increase the strength of the wheel, because the weight thus added also increases the centrifugal force, leaving the wheel no stronger than before.

Fly-wheels are intended primarily to prevent sudden fluctuations of speed, although they usually carry a belt and thus serve as a driving wheel as well as a fly-wheel. Their capacity to regulate speed fluctuation depends upon their weight and speed. If, for example, we should double the speed of a wheel, we would require only half as much weight to secure equally efficient speed regulation. Inasmuch as the cost of a wheel depends directly upon its weight, it is common practice to run fly-wheels at the highest possible speed in order to save weight and economize in cost. What then is the highest speed at which fly-wheels may be run with safety? Evidently there is a danger limit for every wheel, regardless of the amount of material it contains. For wheels made in sections this limit depends upon the efficiency of the rim joints as well as upon the kind of material of which the wheel is made. For cast iron wheels as ordinarily constructed a rim speed of a mile a minute is the limit for safety. The following table is given stating the number of revolutions per minute for cast iron wheels, from one foot to thirty feet in diameter, at which the danger limit is reached.

Diameter of wheel in feet.	Danger limit, revolutions per minute.	Diameter of wheel in feet.	Danger limit, revolutions per minute.
1	1680	15½	108
1¼	1344	16	105
1½	1120	16½	102
2	840	17	99
2½	672	17½	96
3	560	18	93
3½	480	18½	91
4	420	19	89
4½	373	19½	86
5	336	20	84
5½	305	20½	82
6	280	21	80
6½	258	21½	78
7	240	22	76
7½	224	22½	74
8	210	23	73
8½	198	23½	72
9	187	24	70
9½	177	24½	68
10	168	25	67
10½	160	25½	66
11	153	26	65
11½	146	26½	63
12	140	27	62
12½	134	27½	61
13	129	28	60
13½	124	28½	59
14	120	29	58
14½	116	29½	57
15	112	30	56

Table giving the number of Revolutions per minute at which the Rim Speed for Cast Iron Wheels reaches the Danger Limit of one mile per minute.

FAST STEAMERS FOR THE CUNARD LINE.

Scientific American, November 1, 1902, p. 286.

Plans have been submitted to various shipbuilding firms by the Cunard Steamship Co. for building two monster steamers to have a speed of 25 knots (28.8 miles) per hour. While it is not yet positively known, it is believed that these vessels will be 750 feet long, 75 feet beam and have engines of 50,000 horse power. It is not likely that the steam turbine will be seriously considered as it will be thought that too much is at stake to risk fitting two such costly vessels with a comparatively new type of prime mover. Hence it is probable that the great horse power of these ships will be developed in vertical, quadruple-expansion reciprocating engines; and the question which is now under consideration is whether this power shall be developed upon two or upon three shafts. If twin screws are used the proportions of propellers, shafting and engines would be enormous, since they would have to develop and carry probably not less than 25,000 to 27,000 horse power each. There is absolutely no precedent for such sizes and weights, the largest twin engines at present being those of the Deutschland, which, when the boilers have been steaming freely, have developed as high as 38,000 horse power, or 19,000 on each shaft. The new Kaiser Wilhelm II., it is true, is to have engines of 40,000 horse power, or 20,000 upon each shaft, and in actual service they are likely to develop as much as 44,000, or say 22,000 on a single shaft.

It is natural that the Cunard Company in its endeavor to keep down the sizes of the separate engines should turn to the triple-screw system of propulsion. By so doing each shaft would have to carry only 17,000 or 18,000 horse power, or less than is now carried in the case of the Deutschland. The objection to triple-screws is the very obvious one that the engine room staff would have to be greater for three engines than for two. But with this exception, it may be said that practically every other argument is favorable to the use of triple-screws. In the first place, judged from the all-important standpoint of safety of travel, there is less risk of total disablement in a triple than in a twin-screw ship. If one engine should be disabled only 33 per cent of the power is lost, and the ship still has 66 per cent with which to make port. The individual parts of the engine are much lighter, and hence it is easier to overhaul the engine in port, or, in the case of a breakdown, to make repairs at sea. Although it might seem at first that more of the ship's space will be taken up by three engine rooms than by two, the difference is not so great as might be supposed, inasmuch as the center engine would be located on the center line of the ship, astern of the wing propeller engines, and would occupy space in the least desirable portion of the ship from the standpoint of passenger accommodation. Admiral Melville, Chief of the Bureau of Steam Engineering of the U. S. Navy, is a strong advocate of the use of triple-screws, not merely for the navy, but for the large transatlantic steamships. Speaking on the important question of economy he has shown that in the case of the fast commerce destroyers Minneapolis and Columbia, which are fitted with triple-screws, there was a very decided economy realized by their use. Moreover, it is a significant fact that the French naval architects, who are among the best, if not the best in the world, and who are considered to have gone more deeply and thoroughly into the question of triple-screw propulsion than any other naval architects, appear to have adopted the triple-screw exclusively for all the large ships of the navy. They claim that, quite apart from their obvious military advantages, triple-screws show a very decided economy over twin screws. There is one other question which should be carefully considered in adopting twin-screw propulsion for transatlantic passenger ships, and that is the question of vibration, which has so much to do with the comfort of passengers. It is a well-known fact that in the largest high-speed passenger vessels, vibration is one of the most serious sources of discomfort. The effect of triple-screw propulsion in respect to vibration is a question which should receive a most thorough investigation. While speaking of vibration, one cannot but call to mind that the steam turbine, because of the absence of reciprocating parts, that is to say, of more or less unbalanced parts, is the ideal motor for passenger service. There is no question that the first transatlantic steamship that is fitted with a successful steam turbine will have a great advantage in this respect over high-powered boats driven by reciprocating engines. Broadly considered, it must be admitted that the success which has attended the installation of turbine units of great horse power in electrical plants foreshadows the day when the steam turbine will be exclusively used in transatlantic travel. We cannot but think that the Cunard Company should make a most exhaustive study of the existing high-powered turbine plants before they decide that there is any inherent quality of the turbine which renders it unsuitable for use in tandem on the shaft of a transatlantic liner. Already turbines of 7,000 horse power are under contract for electric railway plants. If they can be built in 7,000 horse power they can surely be built successfully in 9,000 horse power units, and two such turbines on each of the three shafts of the Cunard boats would give the desired maximum horse power and something over.

AN AERO-CONDENSER OF 4,500 HORSE POWER.

Bulletin de la Societe des Ingenieurs Civils de France.

According to a paper published in the Proceedings of the French Society of Civil Engineers a very large aero-condenser has recently been established in the plant of the Kalgoorlie Electric Power and Lighting Company, from which power is to be distributed to the mines in Western Australia. It works on the surface principle, making it possible to utilize the water of condensation for the feed and, at the same time, carry a vacuum which, while dependent upon the temperature of the outside air, effects an important saving in coal consumption.

It consists of twenty-seven fans, each 7 feet 2½ inches in diameter and delivering something more than 1,175,000 cubic feet of air per minute against the condensing surfaces. These surfaces are formed of corrugated sheets of steel 1 millimeter (.039 inch) thick and set up in pairs and held together by a mechanical setting so as to form hollow wavy spaces. These plates are then assembled in nests by means of oval joints, that are stamped into the plates themselves at the same time as the corrugations. The plates are held together by two bolts passing through the nests. The form of oval stamped in each sheet forms two distributing passages, through one of which the steam enters while the water of condensation flows out at the other.

The cut shows a section of the fan and a nest of the corrugated plates. It may be remarked that these plates do not suffer any deterioration whatever, since the interior is filled with water and steam containing a small amount of oil that is sufficient to prevent oxidation, while the outside is subjected to the action of dry air only. Experience has shown that plates so constructed will hold their own indefinitely without any change, provided they are not exposed to snow and rain. The fans are run at a speed of but 100 revolutions per minute so that they show scarcely any wear. Hence the cost of maintenance is practically nothing, a matter of prime importance in a plant of this kind. They are placed in groups of three, each group delivering air into a single chamber the top of which is formed by the nests of corrugated plates. The air passes over these surfaces vertically from the bottom to the top for a distance of about 3 feet 8 inches. Steam enters at the top of each nest and the water of condensation is drawn off at the bottom.

In this particular case at Kalgoorlie no attempt was made to economize in space on account of the low price of ground, while, at the same time, the high temperature of the air also tended to increase the dimensions of the apparatus beyond what would be required in a cooler climate. Steam from the engines is first passed through separators and thence into the condensing nests. The pumps handling the water of condensation are fitted with metallic valves on account of the quantity of contained oil which would be injurious to rubber at the high temperatures reached, which sometimes run as high as from 175 deg. to 190 deg. F.

All of this water is sent through two different systems of filters. The water coming from the condensers is almost entirely free from oil and can be used directly as a boiler feed. These filters are of wood charcoal and deliver the water in an almost chemically pure condition, containing only a mere trace of oil. The water taken from the oil extractors is usually sent to the sewer, but owing to the difficulty of obtaining pure feed water at Kalgoorlie the 260 odd gallons drawn per hour from the separators are subjected to a prolonged filtration first through charcoal and then through sponges. In this way, all of the water resulting from the condensation of the exhaust steam is saved and again utilized.

The oil separators used in this plant are formed of a cylinder open at each end and containing a second one concentric with it and perforated with holes. The second cylinder contains a guiding helix or screw. The steam holding the oil in suspension, enters along the axis of the cylinder and, traveling over the screw surfaces acquires a rotary motion whose speed depends upon that of the steam. The particles of oil being heavier than the steam, are thrown out through the perforations in the inner cylinder into the space between the two, whence they are drawn off.

The two-fold object sought to be obtained by this installation is the condensation of all of the steam consumed to be utilized for boiler feeding and securing of a vacuum by which a saving in that consumption will be effected. As for the latter, the following table shows the results that have been obtained with the air at various temperatures:

Temperature of Air, Fahrenheit.	Vacuum in Inches of Mercury.
50.0 degrees	20.87
53.6 “	20.47
57.2 “	20.08
60.8 “	19.69
64.4 “	18.90
68.0 “	18.11
71.6 “	17.32
75.2 “	16.54
78.8 “	15.75
82.4 “	14.96
86.0 “	13.78
89.6 “	12.60
93.2 “	11.02
96.8 “	9.45

Further observations have shown that the average vacuum obtained during the day is 15.75 inches and 20.47 inches at night with the corresponding saving in the use of steam.—G. L. F.

"FIRE-PROOF WOOD" SO CALLED.

From Report of Insurance Engineering Experiment Station.
August, 1902.

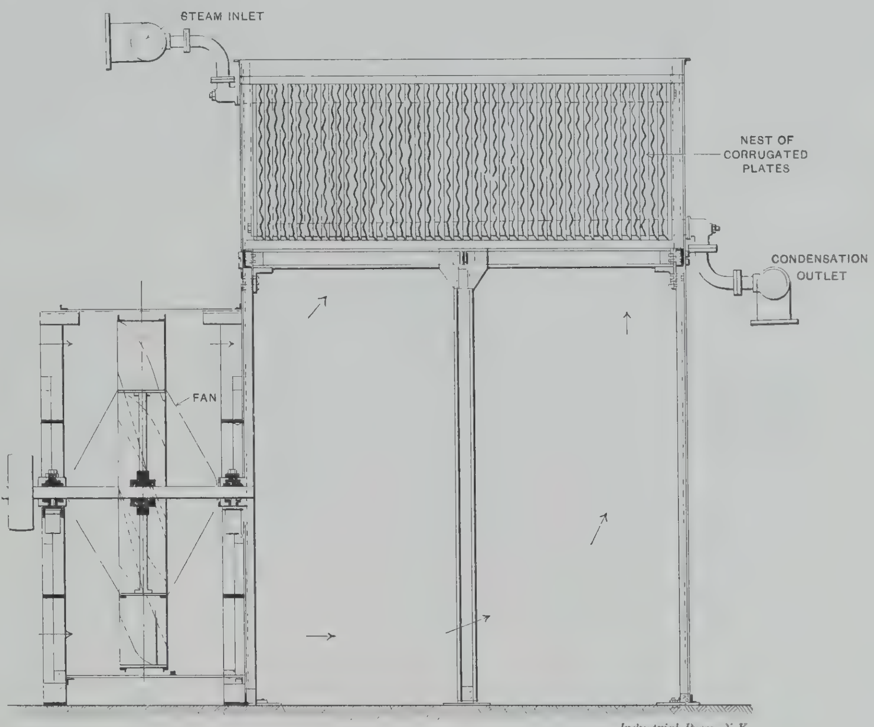
The processes of "fire-proofing" wood by saturating it with a solution which, on drying, leaves the pores more or less filled with crystals that, when heated, give out gases which retard the combustion of the wood, are not new. But the recent discussion as to the real value of such wood in modern buildings in case of fire, and as to the possibility of suitably sampling and testing the product before installing, has led to a series of experiments and examinations which are reported here. If "fire-proof wood" were in any sense fire-proof, this discussion would be unnecessary. It is not. It is similar to untreated wood except in three particulars: it is slightly less liable to be ignited by a brief and feeble application of heat; it is less likely to be ignited permanently by contact with a hot body, as an electric wire or a fragment of a projectile; and, further, it is not so likely to cause as rapid a spread of a fire in some cases, as it burns with less flame.

The wood examined in these tests was furnished by three of the leading manufacturers and since the different specimens were apparently possessed of essentially the same characteristics, it is assumed that they are representative of "fire-proof" wood.

Examination was first made to see to how much higher temperatures the treated wood could be exposed than the untreated, without its igniting or beginning to glow. It was found that the average ignition temperature of untreated woods is 840 F., while that of the treated woods ranged from 850 F. to 940 F.

The value of the treatment is then to raise the igniting point less than 100 degrees F., while some of the treated specimens show no sensible improvement. The data were derived from pieces ¼ inch by ¼ inch by ½ inch, heated at different rates in a small electrical muffle, and the agreement between different samples was within twenty degrees. Twenty samples of each wood were tested and the results averaged. It cannot, in view of these results, be claimed that the treated wood is sensibly less likely to be ignited when a temperature of 1000 degrees F. is reached.

The temperature at which the treated and untreated wood "flash" or flame instantly was ascertained by putting a brass plate into the electrical muffle and raising the temperature at a rate of about five degrees a minute until it was found that a piece ¾ inch by ¾ inch by 2 inches burst immediately into flame on being thrown onto the brass plate. In this test but little difference was found for the flash point of the treated and the untreated woods; in a few cases the treated wood flashed at a lower temperature than the untreated.



Industrial Press, N.Y.

Fig. 3. Sectional Elevation of Kalgoorlie Air Condenser.

The extent of the relative destruction of the treated and untreated wood on exposure to the action of a flame at varying temperatures was carefully studied. With a blast of gas at a temperature of from 1700 F. to 3000 F. for one, two and three minutes, the loss of a cross section of a small specimen is from five to twelve per cent. greater in the case of an untreated wood than in the case of a treated wood.

When subjected to the action of a powerful flame from a blast lamp, the *rapidity* of destruction of a small test piece also serves as an index of the value of the fire-proofing as a preventive of combustion. Specimens ¾ inch by ¾ inch by 6 inches and ¾ inch by ¾ inch by 12 inches were supported in a horizontal position by the ends and a large blast lamp placed under the center. The time elapsing before the stick burned and fell apart was noted. There is no great difference between the treated and the untreated wood in this particular. It was noticeable that all the untreated specimens furnished more flame than the treated.

The "hot plate" test was next tried and showed clearly the characteristic tendency of the treated woods, when in isolated pieces, to char without much flame and to extinguish themselves when taken from the plate. The glow and flame last only a few seconds in the case of any of the treated woods, while they may last from one and a half to two minutes or may last only a few seconds in the case of untreated woods. This test demonstrates the value of fire-proof wood as a safeguard against ignition from electric wires, yet no "hot plate" can compare in intensity with the incandescent metal and metallic vapor of many a short circuit. It is a good demonstration of the added safety of war ships when finished with "fire-proof" rather than natural wood, since one great danger of ignition in war vessels is from hot fragments of metal. In its general application to buildings this test demonstrates very little.

In response to a comment on the part of the manufacturers that large pieces could not be made to burn the following experiment was made: In a large fireplace, between two hard, dry pieces of pear wood, 4 inches in diameter and 12 inches long, there was built a fire of newspaper and "fire-proof" kindling; over this were laid on edge four boards (6 inches by 24 inches, 8 inches by 30 inches, 14 inches by 20 inches and and 14 inches by 30 inches) of "fire-proof" wood. The fire spread up and along the boards, and in about two hours the whole contents of the fireplace, except the pieces of pear wood, were consumed. The two logs were afire, but went out after the "fire-proof" wood had been consumed. The room, in the meantime, had been rendered unbearably hot by the fire, which resembled a good cannel coal fire in appearance.

In the light of the results of these experiments, it would not appear that more can be claimed for "fire-proof" wood than this: That, when heated, it gives off a gas which makes it more likely to fail to keep burning than an untreated piece of wood; and that when afire, it gives out less flame, and hence is not as likely to cause fire to spread. It is not incombustible; it is not uninflammable; it will under many conditions, support its own combustion; it is destroyed by external heat nearly as rapidly as is untreated wood. It is not as easy to work at high speed; it may cause rusting (as do some of these specimens) and the mechanical strength of the wood is slightly impaired.

In consideration, then, of the physical properties of such wood as has been examined and of the difficulty of assuring one's self of the nature of the product; and, further, in view of the possible deterioration of the wood of the fastenings and finish, the use of such fire-proof wood in ordinary buildings seems of very doubtful value.

FASTENINGS FOR EMERY WHEELS AND GRINDSTONES.

Zeitschrift des Vereines Deutscher Ingenieure, September 27, 1902, p. 1481.

When an emery wheel or grindstone is put in revolution a certain amount of tension is set up and the method of fastening should be carefully considered. The oldest fastening for this class of tool is that shown in Fig. 4. The stone has a large hole in its center and is carried by a shaft of the same type as that used on old-fashioned water wheels. It is fastened with wooden wedges, which are soaked with water in order to make them swell and tighten as much as possible. The instability of these wedges, which, by alternate wetting and drying, are constantly varying the tension put upon the stone, serves to increase the danger of the bursting of the same. This style of fastening is, therefore, seldom used at present.

A step in advance was made by the introduction of iron shafts. At first these were square in section. The stone was fastened between two wrought-iron crosses having a square hole at their centers. The ends of the arms were provided with holes through which bolts were passed for the fastening of the stone, as shown in Fig. 5. The crosses were themselves fastened to the shaft by wrought-iron wedges, so that the stone was, in this way, freed from all tension due to its fastenings. It was merely weakened in section by letting the crosses into it and by the holes for the bolts.

An essential improvement was made in the fastenings by the introduction of round shafts as shown in Fig. 6. Here the stone is fastened between two round clamping plates which are drawn together by a nut on the shaft. Through the pressing of these plates the stone is, of course, subjected to a crushing stress; it must, therefore be admitted that stresses are thus set up in it that extend beyond the outer diameter of the plates. As a matter of fact stones so fastened have been sprung to such an extent that all of the material outside the plates has been fractured. Such clamping plates have also been made with circular ribs, as shown in Fig. 7, thus forming a first-class bursting furrow in the stone. These ribs possess the disadvantage that the section of the stone is dangerously weakened by them.

Another form of fastening is that shown in Fig. 8. Here cone-shaped plates are used for clamping the stone. The hollow cones are brought to bear against it. When these come to a bearing the plate must press equally against the stone throughout its whole circumference. As they are pressed together they are distorted to a greater or less extent on account of their own elasticity; their surfaces will be forced back and the diameter of the rims increased. Through the grinding action on the edge of the stone, the latter will increase in size and this increase will be shared by the plates which will thus set up a radial stress. These cone-shaped plates which seem to be so advantageous are, therefore, detrimental in that they exert a destructive influence on the stone.

The fastening by means of plates in the form of inverted cones, as shown in Fig. 9, is a preferable one. Here, by a tightening of the plates, the rim is drawn in towards the center and a tension towards that point is created. The tensions which are produced by the pressing of the plates together are toward the outside, and counteract each other to a great extent, so that there are no unfavorable stresses set up in the stone by this method of fastening. It will

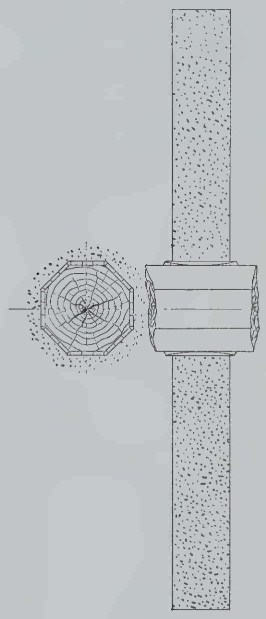


Fig. 4.

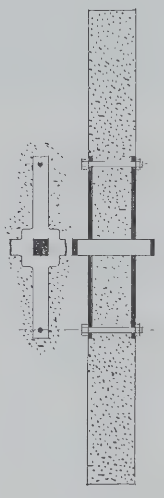


Fig. 5.

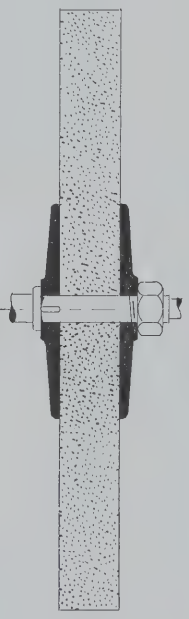


Fig 6.

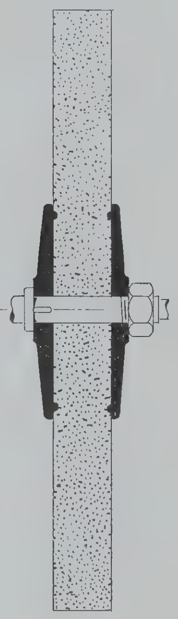


Fig. 7.

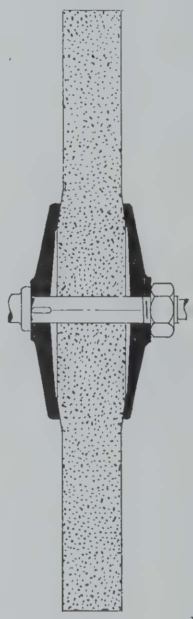


Fig. 8.

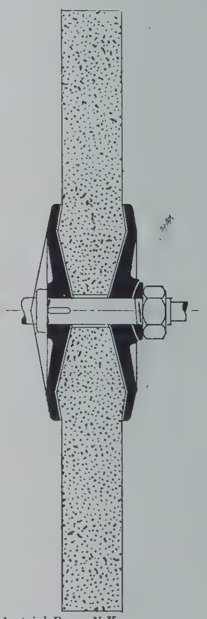

Industrial Press, N.Y.

Fig. 9.

also be of advantage to make the bearing surface of the tightening nut spherical, whereby the plates can be made to better adjust themselves to any inequalities in the stone.—G. L. F.

MACHINE SHOP FLOOR PLATE WITH REMOVABLE SECTIONS.

Power and Transmission, October, 1902. p. 42.

In the early experience of heavy machine work it was the custom to take the work to the machine, but in modern machine shop practice such changes have come about that in many instances the machine is taken to the work. In nearly all modern and well-equipped iron-working plants engaged in work of the heavy class the floor plate has become a necessity, the use of which enables the work under construction to be bolted down to a level surface in the position desired, after which the machine, be it a portable slotter, shaper, planer, boring mill or drill, is set up in position, adjusted and made ready for the performance of its particular office. In other words, the floor plate might be called a universal machine, capable, with proper equipment, of unlimited variations of operation or service and with the greatest economy as to power consumption and cost of labor in resetting work requiring a variety of operations. The size of a floor plate is regulated solely by the requirements it has to meet, and must in all cases be arranged with a traveling crane overhead. The power used for driving the tools is preferably electrical, but rope and air driven tools and flexible shafts are also available.

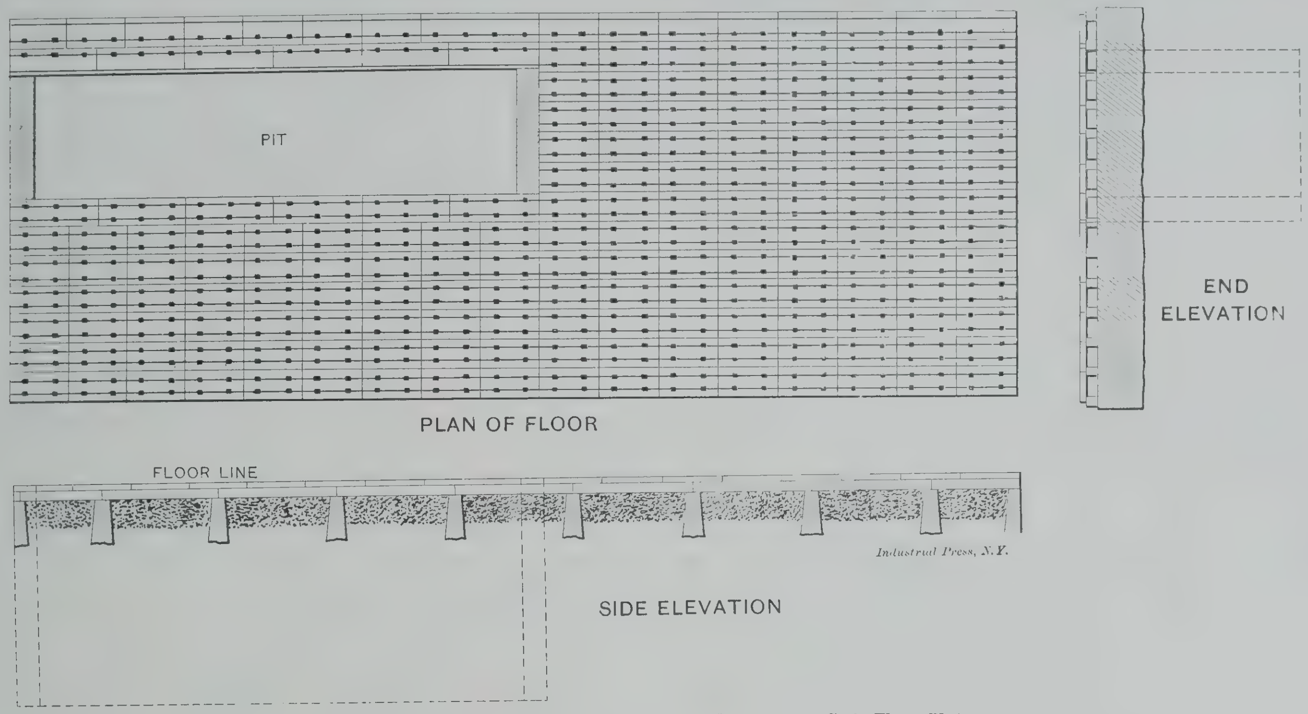


Fig. 10. Plan, End and Side Elevations of Dodge Mfg. Co.'s Floor Plate.

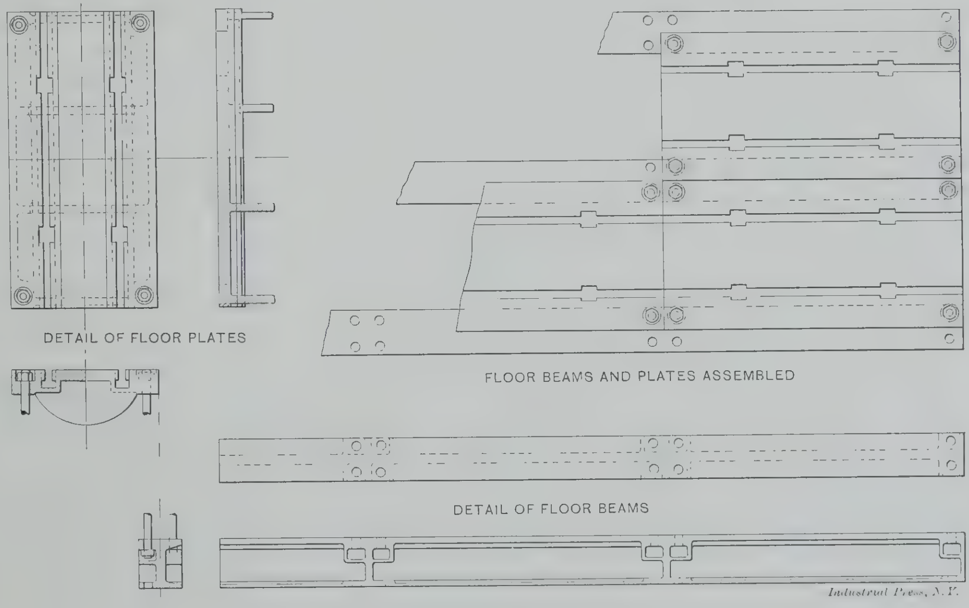


Fig. 11. Details of Floor Plate.

There are numerous plans for laying down floor plates, and the illustrations, Figs. 10 and 11, show the plan adopted at the works of the Dodge Mfg. Co., in their heavy machine department. A feature has been introduced in this floor plate whereby any section that has become pened or warped from hard service may be removed for planing or relieving the strain that it may have undergone, or otherwise correcting inaccuracies and results of wear. After a section has been repaired it may be replaced for further use, or new sections inserted as may be desired. This is a decided advantage as with many floor plates this cannot be done as the sections are cemented solidly into the foundations and no means afforded for maintaining constant accuracy of surface.

The floor plate is located beside the wheel lathe pit. Pieces that are too long or wide for setting up on the surface of the floor plate can be hung or bolted to the side of the pit convenient to the portable tool to be used. The company expect to make it a feature of their business in the near future to supply floor plate installations to manufacturing concerns.

ADJUSTMENT OF STEAM ENGINE SHAFT GOVERNORS.

Iowa Engineer, March, 1902, p. 129.

Adjustments of steam engine shaft governors are made for the purpose of changing the speed of the engine or the sensitiveness of the governor, or both. The action of a governor of this type depends on a change of speed, it being necessary for the engine to run faster with a light than with a heavy load. The less the difference in speed between no load and full load, the more sensitive the governor, and *vice versa*. The two forces acting in opposition in a shaft governor are the centrifugal force of the governor weights and the elastic force of the springs. The initial tension of the springs resists the centrifugal force of the weights and the latter must exceed the tension of the springs before the governor can act when the engine is starting. The more the springs are stretched the greater the tension and the greater the centrifugal force must be to overcome it. The effect of centrifugal force to oppose the springs also depends on its moment or leverage. In some governors the lever arms are variable, and in others the centrifugal force is altered by changing the weights. If the leverage of the weights be reduced and the tension of the springs remains unchanged, the angular velocity must be increased to balance the opposing forces, which means that the engine must run faster. The converse is also true. If the tension of the springs be increased the engine again must run faster, and if the tension is reduced it must run slower.

An increase of the initial spring tension increases the sensitiveness of the governor, and *vice versa*. Sensitiveness is also dependent upon the strength of the springs, a decrease in the strength increasing the sensitiveness, and an increase in the strength decreasing the sensitiveness. Engine speed may therefore be changed either by changing the centrifugal force of the governor ball, or the initial tension of the spring. Sensitiveness of the governor may be changed by change either of the initial tension or of the strength of the spring.

The following is given, not as covering all possible cases, but the suggestions may prove helpful to such as find themselves called upon to adjust shaft governors:

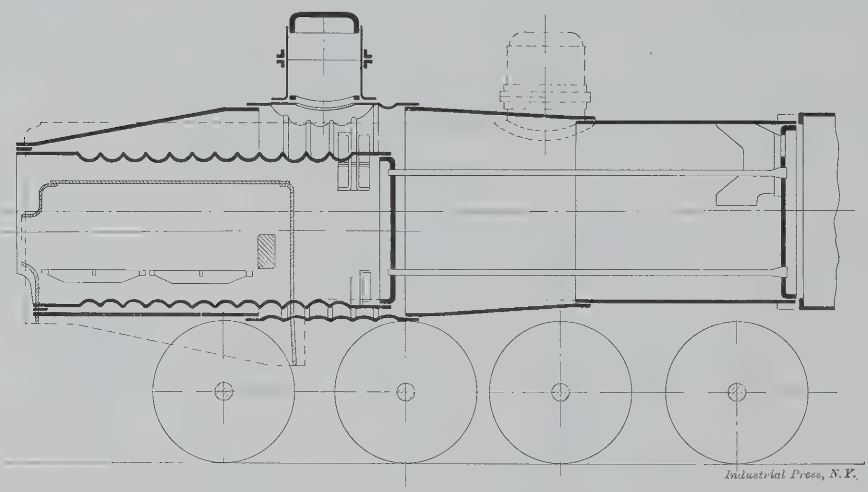

Industrial Press, N.Y.

Fig. 12. Locomotive Boiler with Corrugated Waist and Firebox.

Let M = Moment of centrifugal force of the ball.
S = Strength of spring.
I = Initial tension of the spring.
Sp. = Engine speed.
Sen. = Sensitiveness of the governor.

Sen. Constant	To increase Sp.	Decrease M or Increase I and S
	To decrease Sp.	Increase M or Decrease I and S
Sp. Constant	To increase Sen.	Increase I and M or Decrease S
	To decrease Sen.	Decrease I and M or Increase S
Sp. Variable Sen. Variable	To increase both	Increase I or Decrease M and S
	To decrease both	Decrease I or Increase M and S
Sp. Variable Sen Variable	To decrease Sp. and increase Sen.	Increase M and Decrease S, or Increase M much and I little, or Decrease I much and S little
	To Increase Sp. and decrease Sen.	Decrease M and Increase S, or Decrease M much and I little, or Increase I much and S little

M may be changed by changing either the length of the lever arm, or distance from center of gravity of the ball to the center of pivot about which it turns, or by changing the weight of the ball. Provision in many engines is made so that the ball can be moved on its arm, being held in place by a set screw. In other engines this lever arm is invariable, but the weight of the ball can be changed by varying the amount of lead it contains. It may be changed by pulling up or letting down the spring. This is often effected by means of a "turn buckle" at the end of the spring opposite to that which is attached to the governor. If the spring be a leaf spring instead of a spiral spring, the initial tension can be changed by wedges put back of the spring near its point of attachment; so that the spring before being drawn up has its point thrown into such a new position that it has to be drawn up through a greater or less distance to bring it to the point of attachment. To change S usually requires a new spring if it be a spiral spring. S, however, is increased by reducing the number of coils, and decreased by increasing their number. In the leaf spring, S may be increased by adding more leaves, and *vice versa*.

The foregoing applies particularly to the older style of shaft governors in which the "inertia" principle is not prominent. Inertia governors are generally built and adjusted at the factory for the specified speed and sensitiveness. Subsequent changes, if small, can be made as above indicated for centrifugal governors by substituting moment of inertia force for moment of centrifugal force, but radical changes will necessitate the use of a new spring. Later forms of inertia governors provide for changing the point of attachment of the spring to the weight arm.

LOCOMOTIVE BOILER WITH CORRUGATED WAIST AND FIREBOX.

Zeitschrift des Vereines Deutscher Ingenieure, 1902.

The stayless locomotive boiler designed by Herr Lentz and built for the Left Bank of the Rhine Railway about ten years ago, labored under the two-fold disadvantage of being a poor steamer and subject to leaky tubes. These were due to the form of the firebox, which, being cylindrical, could not be made large enough to afford sufficient grate area, besides being too rigid to permit inequalities of expansion to take place. Mr. Vanderbilt improved this boiler by using a corrugated firebox, which permitted not only an increase of grate area but also gave some flexibility to the structure. The construction, however, does not seem to be all that is required and so the Schultz Knaudt Co., of Essen, Germany, have brought out a further improvement as shown in Fig. 12, in which a certain amount of elasticity is given to the whole structure by making the waist plate in the form of a corrugated sheet. The dome may be placed upon this sheet or upon one of the smooth sheets, as may be desired. Several of these boilers have been built but no reports have yet been made as to their performance in service.—G. L. F.

* * *

Frederick Alfred Krupp, the gun-maker of Essen, Germany, died suddenly of apoplexy, November 22. He was the son of Alfred Krupp and the grandson of Peter Frederick Krupp, the founder of the business. While the grandfather was the founder, it is to Alfred Krupp, however, that the success of the firm is principally due; for all that he inherited from his father, who died in 1826, was an iron forge employing three men, and no capital. Without money or friends he built up the greatest iron and steel business in the world and became the armorer of Europe. He was possessed of great powers for invention and research, and had an indomitable will. Alfred Krupp died in 1887. The general census of July 1, 1898, showed that 40,253 men were employed in the mines, mills and shipbuilding works of this great institution, of which 23,997 were employed in the cast steel works at Essen. Until the formation of the United States Steel Corporation, the Krupp firm were the largest employers in the world, and are now second with about 43,000 men on the rolls. In 1890 the area covered by the building property, was 11,700 acres. Since 1887 Frederick Alfred Krupp has been in charge and during that time the works have been greatly enlarged and almost transformed. He was the richest man in Germany, his fortune being estimated at $125,000,000.

NOTES OF TRAVEL.

CUTTING SPEEDS—DESIGN AND FINISH OF GERMAN AND SWISS ENGINES—SAND BLAST.

Editor MACHINERY:

Although high cutting speeds and heavy cuts for machining iron and steel have been used for some time in the States for heavy work, and the "blue chip" is now well known in the roughing-out process of heavy forgings, little attention seems to have been given to the use of the most recent special steels for rapid machining of small work. In bicycle and automobile construction the steels used for cutting tools have been driven to the utmost service by the aid of copious floods of oil, soda water, emulsions and other liquids for cooling the tool and the work. But the steels used were those which softened at comparatively low temperatures relatively to the high temperatures that the recent steels will withstand. The work done by a cutting tool was much less in a given time than is obtained with special steels.

In the works of Alfred Herbert, Limited, Coventry, England, builders of light machine tools, special steel is used on the milling machines for inserted-tooth mills, turret and capstan lathes, engine lathes, planers, shapers and other machines for performing like services. The small tools are made of "A. W." (Armstrong-Whitworth) and "Magic" steel. During a three-hour inspection of the works, the writer observed that the machines were running at very high speeds and removing metal with great rapidity. Finally an engine lathe of a swing of probably twenty inches was noticed turning off a shaving from what, on account of the white, straight chip, appeared to be lead or something of the nature of babbitt metal. A remark to that effect, however, elicited the information that it was a piece of mild steel undergoing machining, and an examination proved this to be the fact. The cutting tool was "A. W." steel. The cutting was done dry, without the use of oil, soda water, emulsion or anything for cooling the tool and work. The chip showed no color due to heating and the tool kept sharp and made a clean, smooth cut.

A notice posted about the shops, giving instructions as to cutting speeds and feeds, was read later. It is given below from a copy kindly furnished by the company. An idea of what is done can be had by reading it.

The machine tools built at the Herbert Works for this high duty are very heavily proportioned for the service to be performed. They are a combination of what is best both in American and English design and construction. Wide belts are provided for, a feature lacking in many machine tools.

On the whole the visit conveyed a most favorable impression.

Copy of Notice Posted at the Albert Herbert, Limited, Works.

NOTICE.

Trials have been made in these works of tools made of "A. W." steel, and the following tables are intended to show the amount of work that can be done. The tools will work two or three hours at these speeds and feeds. Speeds and feeds much in excess of those given can be used for a short time. A small stream of suds was used when cutting steel; more work can be done with more suds. These tools must in future be used wherever possible.

Reduction on Diam. Inches.	Feed per Inch.	Cutting Speed. Feet per Min.
	Cast Iron.	
1-16	32	85
3-16	32	80
¼	32	75
	Mild Steel.	
1-16	32	100
⅛	16	90
¼	16	85
⅜	32	80
	Cast Steel (No. 8 and Tool Steel).	
⅛	32	50
¼	32	40
¼	16	20

Design and Finish of Steam Engines in Germany and Switzerland.

The great simplicity in the design and finish of steam, gas and oil engines in Germany and Switzerland is strongly impressed upon one by a visit to the machinery department of the Düsseldorf exhibition, Germany, and the great engineering plant of Gebrüder Sulzer (Sulzer Brothers) at Winterthur, Switzerland. Ornamental additions are entirely absent. Cylinder lagging, safety guards and oil shields are made of heavy Russian sheet iron banded, supported and strengthened where necessary with polished steel which is often given the same color as the Russian iron. Even oil cups and other trimmings show no polished surfaces in some cases, at least the surface is not left the color of the alloy. Polished and blackened brass, or polished iron is largely used for these parts. And finally the frame, bed and other cast iron or steel casting parts have their surfaces well filled by the painter and finished to a smoothness and color resembling very closely the Russian iron. The moving parts are polished either wholly or over a considerable portion of the surface, and left bright. The machines are well proportioned, free from sharp angles and projections, and consequently beautiful in their simplicity and strength. They are pleasing to the eye in the same way as a magnificent horse free of all harness and trappings, and convey the impression of strength in the same manner.

Sand-blast for Castings.

The sand-blast for cleaning castings of medium size finds considerable favor in Germany and Switzerland. Castings small enough to go into the ordinary foundry tumbler or rattler are cleaned by the common method of tumbling. The sand-blast machine used for the medium size pieces is entirely different from any the writer has seen or heard of in the States. It is not in any respect similar to the sand-blast nozzle, hand guided for cleaning large castings, and does not take its place. The continental machines on exhibition in the Düsseldorf exhibition and in operation in various industrial establishments were made by Alfred Gutmann, of Ottensen, Hamburg. They have a horizontal circular table about six or seven feet in diameter which rotates slowly about a vertical spindle. The whole machine resembles in a way a horizontal table boring and turning mill. Two blasts of sand are blown down upon the back half of the table, which part is covered over with a sheet metal guard to prevent flying of the sand. The pieces to be cleaned are placed on the table which carries them under the sand-blasts by its continuous rotation. The table is of cast-iron grid construction to allow the sand to fall through. An attendant for one or two machines is required, for turning the castings over at intervals during the constant operation of the cleaner so that all sides will be presented to the blast. The machines are capable of taking anything that can be laid across the table and is not too high to pass under the sheet metal guard, which is placed about fifteen inches above the table. An apron of cloth or paper hung at the edge of the guard adjusts itself to the irregularities of the castings and prevents the sand from flying out.

A smooth, silvery matted surface is imparted to the casting by the complete removal of adhering and imbedded sand from the mold. Of course the scale can be completely removed if desired.

The sand used in the blast is exceedingly coarse. The force of the blast does not seem to be great, and there is no dust about the machine to cause discomfiture to the operator. It can be satisfactorily used in the open space of a foundry or cleaning room, which is not true of the high velocity sand blast nozzle tried and usually discarded for castings too large for a tumbling barrel.

Complete satisfaction with the machine was expressed in all the establishments where it was seen in operation.

Florence, Italy. FORREST R. JONES.

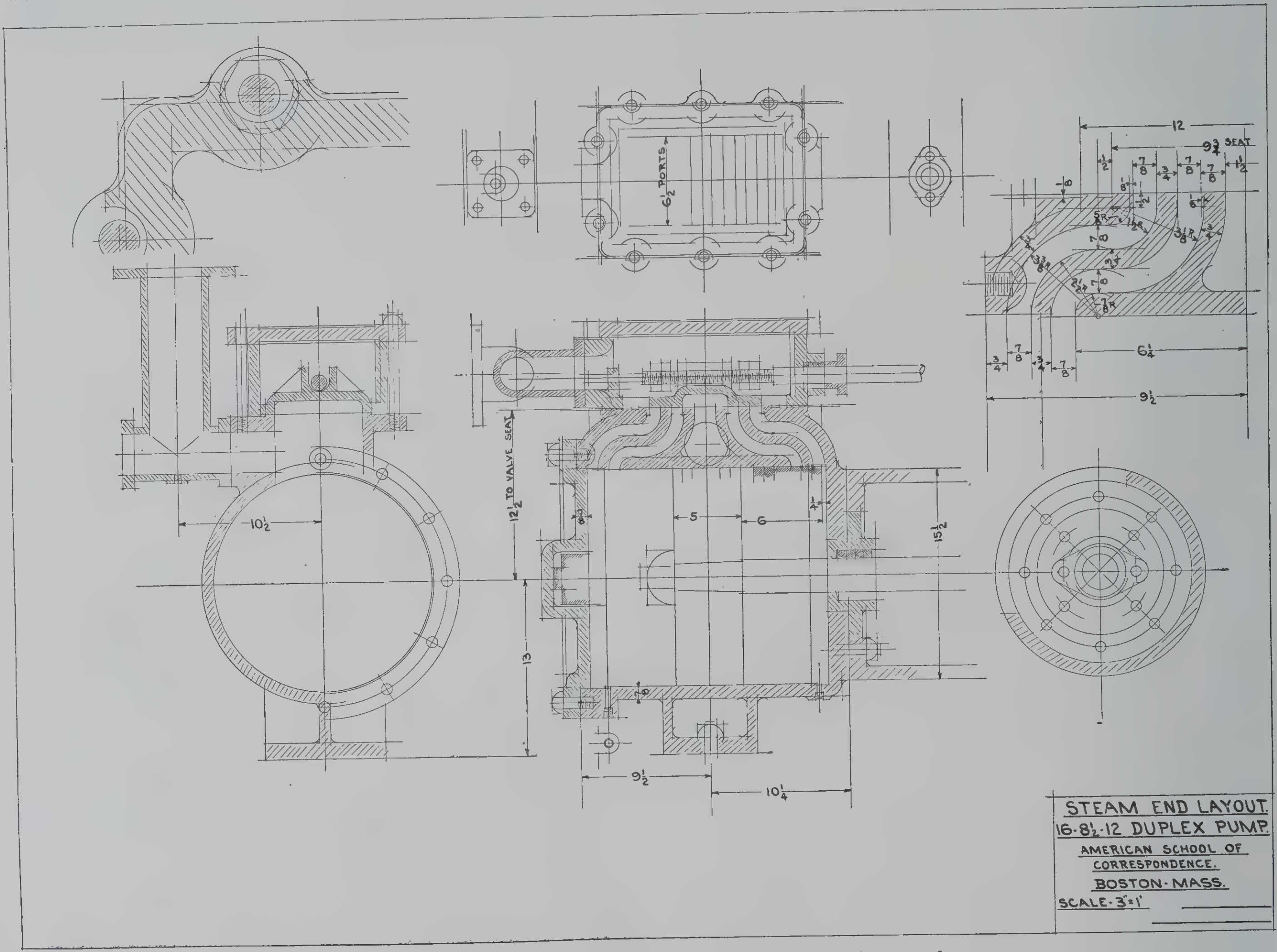
* * *

To anneal self-hardening steel so that it can be drilled and worked without much trouble J. W. Riley says: Heat the steel to a forging temperature, have some dry ashes laid on the floor and covered over with a layer of pine shavings. Lay the hot steel on the shavings, let it burn a little and then cover over with pine shavings and pack dry ashes over the top, making it air-tight. Let it remain until cold. To temper double gasket cutters heat the edges slowly to a tempering heat, not letting the body get very hot, and then cool in oil. The temper is then drawn to a dark straw.

MECHANICAL DRAWING.

AN EXTRACT FROM THE INSTRUCTION PAPERS OF THE AMERICAN SCHOOL OF CORRESPONDENCE.

In a course of mechanical drawing prepared by the American School of Correspondence, Chicago, Ill., Part VI is devoted to working drawings and was prepared by Chas. L. Griffin, Professor of Mechanical Engineering, Syracuse, (N. Y.) University. This pamphlet contains some of the most common-sense suggestions that we have seen, for the benefit of the student in drawing. It takes up the working drawings of a duplex direct-acting steam pump and follows them through from beginning to end. Mr. Griffin touches on one point in particular that should be impressed on the student in drawing, and that is, the method of blocking out or arranging the parts of a machine when designing; and he shows in a very clear manner what the essentials are in such work and how the sketches of a designer should appear when turned over to the detail draftsman. The accompanying illustration is one of several from this pamphlet and the quotations which follow indicate in a general way the direct and practical method adopted by the author.



Specimen Plate from Instruction Papers of the American School of Correspondence.

The two chief requisites of a shop drawing, under which general heads a multitude of detail requirements can be summed up, are:

(1.) Absolutely complete and definite instructions from designer to workman.

(2.) Least possible cost in dollars and cents of production of the drawing measured by the draftsman's time.

It makes no difference how much we may attempt to disguise these two elements, the fact will still be apparent that "*complete instructions furnished for the least money*" is what the manufacturing shop is after, and what will be assumed as a basis for judgment as to the highest commercial utility.

As to the first point, that of completeness and definiteness of instruction, there must be no question of degree. If the information which the drawing furnishes is positive and complete, the drawing is good. If doubt arises in the workman's mind as to what the designer intended by a certain line or dimension, or if the dimension be omitted, the drawing is bad. There is no middle ground. The instructions are either present or absent, and the drawing good or bad accordingly.

The workman of to-day is not permitted to assume dimensions or shape. It is his business to execute the draftsman's orders; it is, however, often his privilege to choose his own way of doing it, but further than this modern practice does not allow him to go. He is held as rigidly to the orders specified by the drawing as the locomotive engineer is held to his bit of tissue telegraphic order to proceed, without which he dare not enter the next block. The drawing is supreme; it is official; it must be plain, direct and all-sufficient. It is the draftsman's business to make it thus, and he is not a draftsman until he does.

This idea of positiveness must be thoroughly absorbed by the student. Positive action must be a habit which controls his every move, which marks every dimension he prints, which directs every line he draws. Every line must mean something, must have a definite reason for existence, must be necessary to illustrate the idea he wishes to convey to the workman; and every line must be a definite measurable distance from every other line, so that its location is fixed beyond a doubt. Lines which mean nothing, and cannot be measured, have no place on the drawing; they only confuse it.

Drafting-room labor is a relatively high-priced service, and the salary list easily assumes considerable proportions, so that wasteful excesses count up rapidly. One of the qualifications of proficiency invariably required for this department of shop organization is rapidity of execution. This is not dependent upon personal traits as at first might be supposed. A man may so husband his time and direct his efforts that he will easily distance his neighbor of more rapid motion. The latter may have less ability to make his energies count, and lack of judgment as to when just enough, and no more than enough, energy has been expended on his drawings. From the standpoint of *utility*, the function of a drawing is fulfilled when it has reached the stage that it *completely* instructs; more time spent in elaboration is wasted, and is an unnecessary and therefore extravagant expenditure. The student must fully realize this. In his earnestness to produce finished and complete work he must constantly strive to accomplish results in the least possible time. This does not mean careless haste; far from it. A complete shop drawing cannot be made by short cuts, but through a systematic building of line on line, dimension on dimension. This is in sharp contrast to a haphazard habit of developing a drawing, first a line here and then a figure there, with no definite purpose in mind, and no hint as to when the drawing is actually completed.

The one method constitutes the efficient draftsman who works easily, receives a high salary, and is worth it, because he wastes no time in unnecessary labor. The other marks his unfortunate brother, plodding laboriously far behind, receiving a small pittance per hour, and worth less, because he does uncalled-for labor, and loses his definiteness of purpose in a maze of unexplainable lines and figures.

A working shop drawing, commercially considered, may well be defined as being *"Complete instruction from designer to workman issued at minimum expense."*

The plate on previous page shows, as well as reproduction can accomplish, the pencil layout of the steam end of a direct acting steam pump. The layout is the first work of the designing draftsman. The drawing, as shown, is exactly the type of layout which he would turn over to a detail draftsman, whose duty would be to work up detail shop drawings therefrom.

The character of this drawing should be carefully studied. Remember that it is a layout, nothing more; also bear in mind that it is an exact, measurable working sketch. Attention is called to the sharpness of the lines, especially to the clean-cut intersections. Note the boldness, dash and businesslike style, the free-hand cross-section lines roughly put in. There is no hesitation or worry as to where the end of the line should be, or whether it crosses other lines which it theoretically should not. The intersections are allowed to indicate the termination of lines, and the rough section lines pick out the parts and separate them clearly to the eye. In this layout there is the spirit of confident, definite and rapid action, with no thought for absolute finish in line work, but with every thought for absolute results as to measurable dimensions.

There are two general rules of action in producing a drawing, which give the answer to the question that oftenest confronts the beginner: "What is to be done first?" or "What is to be done next?" These rules are:

1. Draw everything that is positively known.
2. Work from the inside to the outside.

Every problem has some positive data, assumed or calculated, to start with. The first thing to do in every case is to get this data represented by lines on the paper. An expert designer has been heard to say that until he had spoiled the blankness of his sheet of paper by some lines, he could not design. There is something in this; and almost invariably the first line to draw is a horizontal center line somewhere near the middle of the sheet; draw it! Draw it at once without hesitation, and the layout is begun. We now have something about which to build.

In this case the designer would first calculate the size of the piston rod, and determine the fastening to the piston. He would then draw the rod and build a hub around it. He would next calculate the width or thickness of piston and size of packing rings, and draw the two vertical lines 5 inches apart, to indicate the piston faces. These lines would be limited by the cylinder bore, which he knows to be 16 inches; hence horizontal lines 16 inches apart, parallel to and symmetrical with the center line, are the next to be drawn. Short vertical lines indicate the location of the packing rings. As the nominal travel of the piston is to be 12 inches, the location of the piston and rings can be shown on both sides of the central vertical line at the limits of travel. A clearance must exist between the heads and the piston (in this case ¼ inch is allowed), hence the lines of the heads can be drawn, and the general inside outline of the cylinder barrel is complete.

This is all in direct application of the foregoing rules, and is so simple, natural and direct that it hardly requires such explicit statement. We have simply taken such data as we had and put it on paper, placing it where it can be seen from all sides, and where the mind is relieved of the labor of carrying it.

If the student will only appreciate this one rule and draw all he knows about the problem, he is well on his way to its solution. *Draw everything you know, and work for what you don't know*, is what these rules say, and the first question to arise should be: "Have I drawn everything that is known about the problem?" before he asks himself or any one else: "What shall I do next?"

One other rule might be added to these two: *Keep dimensions in even figures, if possible.* This means that small fractions should be avoided. It is just as easy to bear this point in mind, and save the workman much annoyance and chance of error, as it is to disregard this matter. Even figures constitute one of the trade-marks of an expert draftsman. Of course a few small fractions, and sometimes decimals, will be necessary. Remember, however, that fractions must in every case be according to the common scale; that is, in sixteenths, thirty-seconds, sixty-fourths, etc., never in thirds, fifths, sevenths, or such as do not occur on the common machinists' scale.

* * *

THE NEW YORK 1902 MEETING OF THE A. S. M. E.

The American Society of Mechanical Engineers will hold their annual New York meeting at the Society House, No. 12 W. 31st Street, New York, beginning Tuesday, December 2, and ending Friday of that week. The titles of the papers to be read, are as follows:

Smoke Prevention by Mechanical Stoking. F. R. Hutton.

Volumetric Elasticity of Rubber. F. J. Miller.

Heat Resistance—The Reciprocal of Heat Conductivity. William Kent.

The Metric System. F. A. Halsey.

Final Report of Committee on Standard Methods of Testing Steam and Gas Engines.

A Rational Solution of the Measurements of Weights and Measures. Sydney A. Reeve.

Tests of a Twelve Horse Power Engine to Determine the Effects of Changes in Speed, Load, Point of Ignition, Ratio of Gas to Air, and Jacket Temperature. Prof. C. H. Robertson.

Deflection of Beams by Graphics. W. Trinks.

Entrophy Analysis of the Otto Cycle. S. A. Reeve.

Value of a Horse Power. A. F. Nagle.

Finer Screw Threads. Charles T. Porter.

Filing System for Office. Henry M. Lane.

Gift Propositions for Paying Workmen. Frank Richards.

Fly-Wheel Capacity for Engine-Driven Alternators. Walter I. Slichter.

A Forty-four Foot Pit Lathe. John M. Barnay.

Use of Surveying Instruments in Machine Shop Practice. C. C. Tyler.

Rotary Pumps. John T. Wilkin.

Continuous Record of the Position of an Engine Governor and the Speed of the Engine Which it is Governing. J. C. Riley.

Centrifugal Machines and Their Uses. Bartholomew Viola.

A New Oil-Testing Machine. Albert Kingsbury.

The officers named by the nominating committee to be voted for, are as follows:

For President—William Sellers, Philadelphia, Pa.

For Treasurer—F. H. Stillman, New York; F. H. Daniels, Worcester, Mass.

For Vice-Presidents—James Christie, Philadelphia, Pa.; John R. Freeman, Providence, R. I.; R. C. McKinney, New York.

For Managers—S. S. Webber, Trenton, N. J.; Newell Sanders, Chattanooga, Tenn.

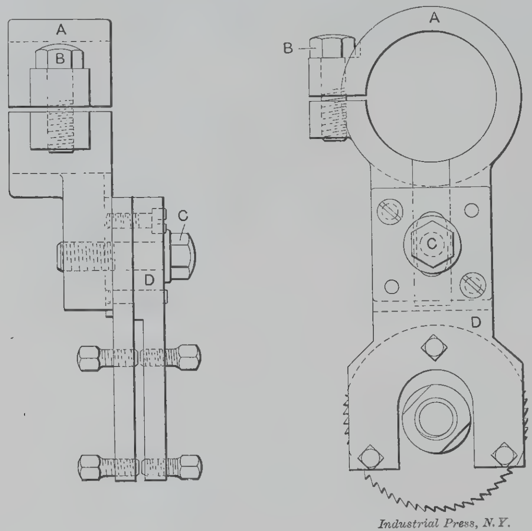
LETTERS UPON PRACTICAL SUBJECTS.

A GUIDE FOR DEEP SAWING.

Editor MACHINERY:

In cutting deep slots with a thin saw, it is common practice to overcome the tendency of the saw to run out of its course by reversing the usual direction of rotation and running it down onto and with the work. The table is either gibbed up more tightly than usual, or held back against the feed screw by a weight to take out the back lash, and prevent the work from running into the cutter. With unusually thin cutters, however, even these precautions fail to keep the saw from running out and breaking. The device described below was contrived by a milling machine operator who had much of this work to do, and it has proved to be very useful. *A* is a casting, bored out as shown to encircle the overhanging arm of the machine. It is split on one side, and furnished with a screw *B* to clamp it in position. To the lower end of this casting is adjustably fastened, through screw *C* and the tongue shown, the holder *D* made of two pieces of steel screwed and doweled together. This holder is brought down over the saw and arbor as close to the work as possible, and carries six snugly fitting brass screws, arranged as shown in the drawing. The flat ends of these screws are adjusted so that they just touch the saw on each side, and thus confine it closely to its proper path. It has been found that this arrangement, when carefully used, will greatly reduce the breakage of the saws in deep cutting.

R. E. F.



Industrial Press, N.Y.

Guide for Thin Milling Saw.

A CONVENIENT BORING BAR.

Editor MACHINERY:

The boring bar shown in the accompanying sketch is for use with a hollow spindle lathe for boring long holes in chucked work where the spring of the common boring bar gives trouble. Fig. 1 shows the bar *H*, a section of the lathe spindle *S*, faceplate or chuck *F*, and the bushing *B*. This bushing is fastened to the faceplate with two flat-head screws when the end of the spindle is flush with the faceplate, but when the faceplate projects beyond the end of the spindle, the bushing is made flush with the faceplate and a screw is put in the joint between the two, half of its thread being in each piece.

The cutting tool *T* is made of round stock and is set by an adjusting screw *C*, at the back side of the bar, and is fastened in position by means of the setscrew *E*. The clamping block *F* is shown in Fig. 2, in position on the cross slide of the lathe, *D*. When the nut is screwed down on the bolt *A*, it clamps both the bar and the block firmly to the cross slide.

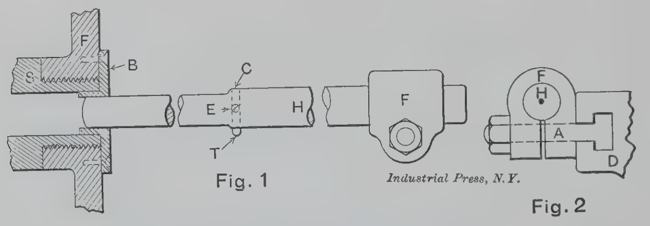


Fig. 1

Industrial Press, N.Y.

Fig. 2

Boring Bar for use in Lathe.

In making the clamping block the hole for the bar should be bored with a common boring bar, between the lathe centers, with the block clamped in position on the cross slide by the bolt *A;* this insures the hole being bored the correct height (it being assumed that the cross slide has no tilting device.) After the block has been bored a close fit for the bar, the slot is cut. The block should be bored for the largest size of bar that will be used and bushings made for the smaller bars. The end of the bar entering the hollow spindle is made smaller than the remaining portion, to allow it to be used in small holes and still keep the greater portion heavy and strong; but if desired, a straight bar could be used which would be somewhat cheaper to make.

A tight-fitting leather washer slipped on the end of the bar before it enters the bushing *B* will keep dirt out of this bearing and prevent undue wear.

When setting the bar, the tail-stock should be straight with the ways of the lathe and the cross-slide so set that the center of the bar will come on the tail-stock center.

It is always advisable to place the clamping block as near the cutting tool as the length of the hole to be bored will allow.

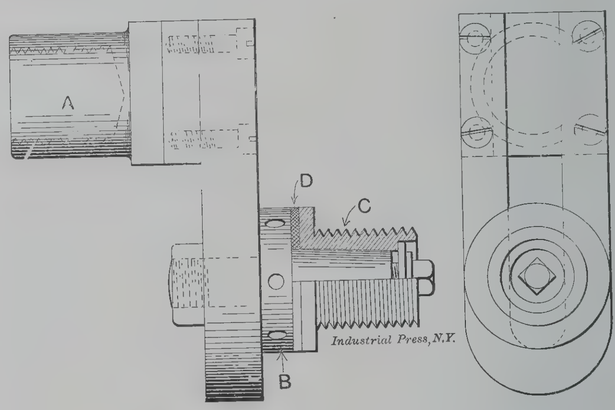
M. H. BALL.

Watervliet, N. Y.

ECCENTRIC BORING ATTACHMENT.

Editor MACHINERY:

A large number of small shops are not equipped with a lathe chuck in which articles can easily be chucked eccentrically so as to turn the article "off center." Even in shops that are equipped with combination universal and independent chucks it is always more or less trouble to chuck a piece in this manner, especially when a great amount of eccentricity is required or where the castings are of peculiar shape. In a great many cases it will be found very difficult to chuck certain pieces just where they are wanted even with the best chuck on the market.



Industrial Press, N.Y.

Lathe Attachment for Eccentric Boring

The sketch illustrates a very simple attachment that can be fitted to the spindle of a lathe, to be used with any kind of a chuck, for obtaining any amount of eccentricity that is within the range of the swing of the lathe.

This attachment may be made in one piece of cast-iron or it may be made of machinery steel, with the parts fitted together as shown in the sketch. When made in the latter way it is, of course, much more substantial than when made of cast-iron. The stock *A* is bored out and threaded to fit the spindle of the lathe on which it is to be used. In the yoke slides a T-bolt *B*, which can be moved to any distance off center that is within the limits of the yoke. On this T-bolt is the sleeve *C*, which is turned and threaded to the same size as the nose of the lathe spindle and is so arranged that it can be turned on the bolt, or by removing the back washer *D*, it can be clamped solidly to the bolt. If it is desired to bore a hole in a disk, two inches off center, all that is necessary is to set this T-bolt two inches from the center of the lathe spindle, clamp the sleeve solidly to the bolt and then screw on the chuck in which the disk has been chucked centrally. If it is necessary to bore a number of holes in the disk, each two inches from the center, all that is needed is to loosen the sleeve after each hole has been drilled and allow the chuck to revolve about the bolt *B* until each successive hole is brought in line with the center of the spindle.

This attachment can be adapted to a great variety of work and by graduating the yoke it can be very quickly set to any desired distance off center. If it is intended to use it on a high-speed lathe it will be necessary to extend the yoke on both sides of the center in order that a counterbalance may be attached to the outer end to balance the weight of the chuck.

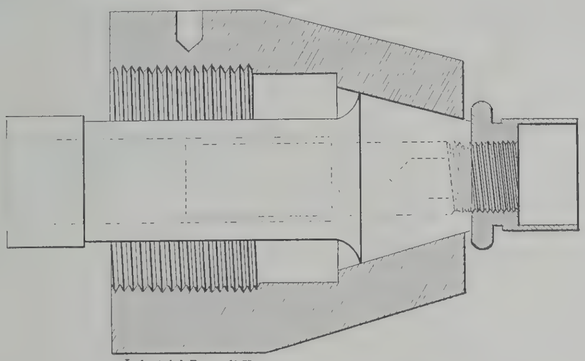
Burlingame, Kansas. CHAS. G. TAYLOR.

A SCREW MACHINE CHUCK.

Editor MACHINERY:

In the October issue of MACHINERY appeared an article under the heading: "A Screw Machine Chuck." I think the chuck is very expensive for the work done, and I send a sketch of a simple device that I have used for years, with good results, on the same class of work on a wire feed screw machine.

It consists of a plain piece the same size as the thread tapped in the piece to be operated upon, with one end threaded to fit the tapped hole.


Industrial Press, N.Y.

Chuck for use on Screw Machine.

The method of operating is to tighten the arbor in the chuck, screw on the piece, perform the operation; then to loosen the piece, open and close the wire feed chuck quickly which pushes the arbor out just enough to loosen the piece so that it can be easily unscrewed with the fingers.

Denver, Col. J. F. SHAY.

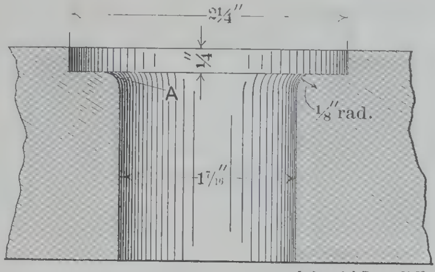
MORE COUNTERBORES.

Editor MACHINERY:

We recently made a tool for counterboring the holes shown in Fig. 1, and at the same time rounding the corners at *A*. The tool we first tried is shown in Fig. 2. It was simply a piece of 1 7-16 cold-rolled steel shafting with a 5-16 square tool held in by a setscrew. With the cutter properly ground and set it worked quite satisfactorily but as the cutter had to be removed for grinding and did not retain its form, it was somewhat difficult to keep it doing the work uniformly. So, an improvement being in order, we made the counterbore shown in Fig. 3, which is the tool now in use. There are two cutting edges and it is made to retain its proper form until comparatively worn out. The shank is tool steel, as well as the cutter, and the teat is hardened, having been ground to size after hardening.

Tools of this kind are quite readily made in the lathe. For this one a lathe was used with a four-pitch leadscrew and geared to cut one thread per inch. The cutter blank being turned it was put on an arbor in the centers and lines were scribed on the outside parallel to the axis and diametrically opposite, to indicate the location of the cutting teeth, and with the point of a thread tool a helical line was started from each parallel line and drawn half way around the blank. Then the gap in front of each tooth was cut in the shaper (on a radius) and the helix roughed out. The finishing was comparatively easy, the tool did not have to be withdrawn and the power crossfeed was used. A cut was started from the outside at one of the cutting edges and fed toward the center; when the opposite gap reached the tool the leadscrew nut was disengaged and the carriage moved back two threads on the leadscrew. The cut was then continued as before. The lathe was run by power part of each half revolution.

It will be seen that matters were much facilitated by the even pitch of leadscrew and by lathe being geared to 1 inch of carriage travel per revolution of spindle. With an uneven pitch of thread on the leadscrew it would have been necessary to withdraw the tool at each gap and it would have been more difficult to get the cutting edges on a line at right angles to the axis. The same trouble would have been experienced if the lathe had been geared to a fraction of an inch. It may not always be possible to gear the lathe to a pitch so well suited to easy manipulation as we did with this tool, but in this case it produced a nice angle of clearance. Taking the largest diameter, 2¼ inches, the circumference is 7.07 inches and with one inch advance per revolution the clearance is about 8 degrees, increasing toward the center.



Industrial Press, N.Y.

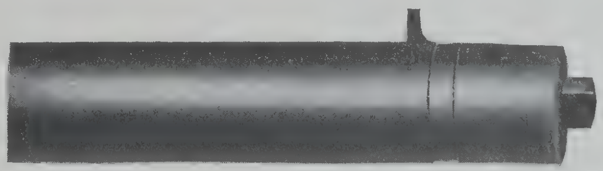
Fig. 1. Hole to be Counterbored.

Grand Rapids, Mich. CORNEIL RIDDERHOF.

MARKING DRILLS AND TAPS.

Editor MACHINERY:

With all the progress that has been made within the last 20 years in small tools such as drills, taps and reamers, one thing has been lost sight of and that is the proper stamping of the same. As long as these were only hand tools the stamping as of old was all right, but this is no longer the case. But few shops have separate taps for hand and machine use, and when the hand tap is put into a chuck it is only a short time before the shank is so badly mutilated that the stamping is beyond recognition. For this reason the custom of marking the size on the shank, just below the square, is entirely out of place. Some manufacturers have adopted the plan of stamping reamers between the flutes and the shank, which is the only correct way.



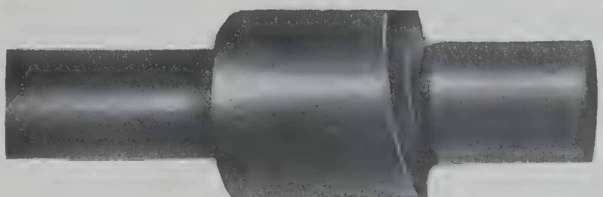

INDUSTRIAL PRESS N.Y.

Fig. 2. The First Counterbore. Fig. 3. The Present Counterbore.

For marking taps, as most of the taps of the present day are made with concave flutes, I see no reason why they cannot be stamped there, if the marking wheel or stamp is made to conform to the shape of the flutes. This would however be practical only in sizes above, say, 3-16 inch. I do not think that the stamping in the flutes will influence the pitch or make the tap warp enough to cause any trouble.

The troubles with taps and reamers, however, are nothing compared with those which arise from the improper marking of the twist drill. The number of sizes is so unlimited and the difference in sizes so slight that accurate marking is an absolute necessity. If one looks over a lot of twist drills that have been in use for some time he will find that some of them are worn a full thirty-second of an inch below size and any marks that may have been on the shank have long since been obliterated.

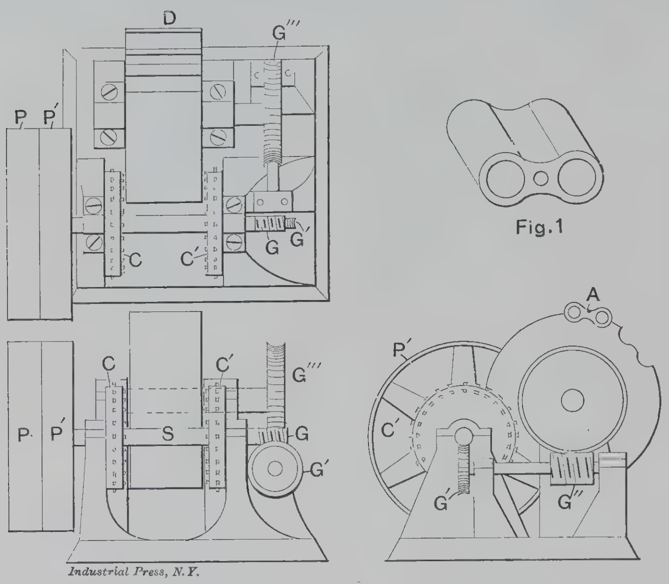


Fig.1

Industrial Press, N.Y.

Fig.2

Machine for Continuous Milling.

In a tool room where hundreds of drills are exchanged every day the time lost in looking up the sizes is by no means a small matter, not taking into consideration the amount of work that is spoiled, due to mistakes arising from lack of proper markings.

Now, as a remedy for these troubles, I would suggest that a flat be milled at the upper end of one of the flutes and the drills marked on this flat. This need not be very large, for small figures that will stay are much better than the present large figures that are worn off after the drill has been used a few times. The milling need not be very deep, as that part of the drill nearest to the flute is worn the least.

Another way would be to turn a small groove around the shank near the flutes, but this would have the objection of weakening the drill and would not be practical with the smaller sizes.

I would like to hear from some of the readers of MACHINERY on this subject, in hopes that a better method might be adopted for marking this much abused tool. Even if the stamping added a slight increase to the cost, the benefit derived would certainly warrant it. CHAS P. THIEL.

Lawrence, Mass.

A CONTINUOUS MILLING MACHINE.

Editor MACHINERY:

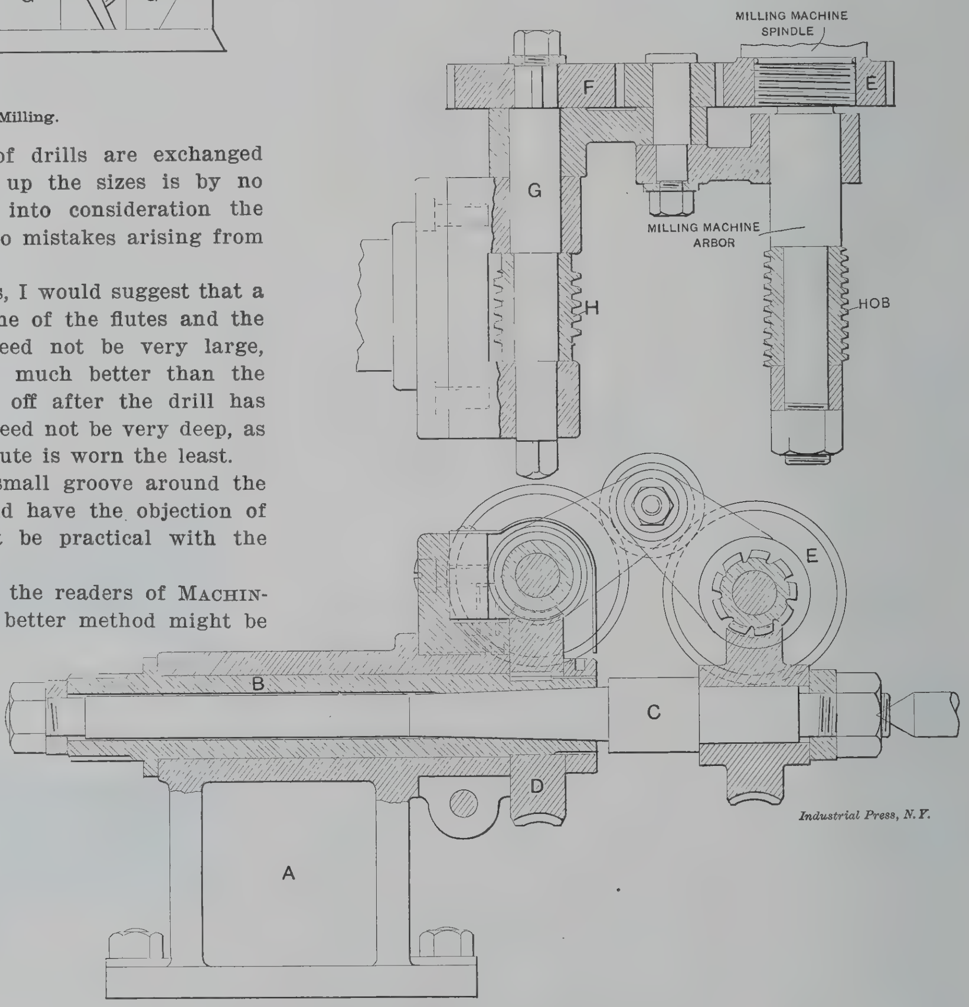
In Fig. 1 is shown a piece of work, a large number of which were to be finished on each end, all to be of the same length. This was accomplished in the continuous milling machine shown in Fig. 2. On the shaft S, bearing the tight and loose pulleys P and P', is mounted a pair of inserted tooth milling cutters, C, C', which are set the proper distance apart to enable them to face both ends of the work to the required length. On the outboard end of this shaft is worm G driving the wormwheel G'. This in turn drives the second worm G'' and the wormwheel G''', which is on the end of the shaft carrying the drum D. The periphery of this drum is shaped to form a series of seats suitable for holding the work. Only two of these seats are shown in the sketch, but on the machine they are continued around the entire circumference. A piece of work is fastened into each of these pockets, as at A, and is slowly fed between the milling cutters by the revolving drum. As each finished piece comes out from the cutters it is removed and an unfinished piece put in its place without stopping the machine. The surface of the drum is thus kept continually covered with work and the operation is continuous.

Connersville, Ind. E. M. BURGESS.

A HOBBING ATTACHMENT FOR THE MILLING MACHINE.

Editor MACHINERY:

In our line of work we have to make quite a number of wormwheels and until recently they were cut by first being nicked with a gear cutter and then finished with a hob, the hob rotating the wheel as it was cut. This was a very slow job so I made the device shown in the sketch which did away with the nicking and indexing. We had a headstock like A, which was used for circular milling; from this I removed the spindle B and bored out the rear end of it to suit a standard taper. I then made an arbor, C, on which was placed the wormwheel to be hobbed. The gear E fitted on the nose of the milling machine spindle and had the same number of teeth as the wormwheel D; and the gear F, on the shaft G, had the same number of teeth as the worm gear to be hobbed. This arrangement feeds the blank around at exactly the same rate that it would be fed by the hob and at the same time relieves the hob from all work other than the actual cutting of the teeth. Worm gears of any number of teeth can be cut by changing the gear F to one having the same number of teeth as is desired for the worm gear. Both hob and worm H have single right-hand threads, so for hobbing left-hand worm gears two intermediate gears are placed between gears E and F. For cutting gears of coarse pitch the foot stock center is used to support the arbor C. With this device we are able to finish worm gears in about one-quarter of our former time.



Industrial Press, N.Y.

Milling Machine Attachment for Hobbing Worm Wheels.

Hamilton, Ohio. HERMAN ISLER.

COMPOUND INDEXING.

Editor MACHINERY:

Having charge of the milling machines in a shop where a great variety of gears had to be cut on machines having but one index plate, it so happened that we had to send many of the blanks to be cut outside or spend a great deal of time figuring out the movements for compound indexing. I therefore made out a list of the gears that could not be cut with any single circle but which we could cut by compound indexing with two circles. I found 65 of these, as will be seen by referring to the accompanying table. This table is made out for use with the index plate of a Cincinnati milling machine, but is, of course, applicable to any index head in which the ratio of the worm to the worm gear is 1 to 40.

In order to use the compound indexing method it was only necessary to make a small index pin, mounted in a slotted brass casting, which was bolted on one of the screws used for clamping the dividing head. The side locking device having been removed, the index pin in the back holds the plate rigid while the forward movements are being made.

In referring to the table, the plus sign (+) indicates that the movements should be in the same direction, to the right; the minus sign (—) indicates that the first movement, at the left of the sign, should be made to the right, while the second movement, at the right of the sign, should be made to the left.

TABLE FOR COMPOUND INDEXING ON CINCINNATI MILLING MACHINE.

No. of Divisions.	Circle.	Holes.	Circle.	No. of Divisions.	Circle.	Holes.	Circle.	No. of Divisions	Circle.	Holes.	Circle.
51	42	28 + 4	34	154	66	3 + 6	28	258	30	20 — 22	43
57	66	22 + 14	38	161	46	18 — 4	28	259	37	11 — 7	49
63	18	2 + 22	42	171	38	11 — 3	54	266	38	3 — 3	42
69	24	16 — 4	46	174	18	6 — 6	58	273	49	21 — 11	39
77	28	12 + 6	66	182	39	3 + 6	42	276	18	12 — 24	46
87	58	46 — 6	18	186	18	3 + 3	62	279	18	11 — 29	62
91	39	6 + 12	42	187	34	15 — 15	66	282	47	38 — 12	18
93	24	8 + 6	62	189	28	8 — 4	54	286	39	9 — 6	66
99	66	34 — 2	18	198	18	2 + 6	66	287	41	35 — 35	49
102	42	14 + 2	34	203	28	6 — 1	58	288	38	16 — 16	58
111	66	22 + 1	37	204	34	1 + 11	66	294	49	23 — 6	18
114	42	28 — 12	38	207	18	7 — 9	46	301	43	18 — 8	28
117	39	9 + 6	54	209	38	9 — 3	66	306	54	15 — 5	34
119	42	24 — 8	34	217	28	2 + 7	62	308	66	18 — 4	28
123	41	27 — 22	66	222	37	19 — 18	54	329	47	46 — 24	28
126	42	4 + 4	18	228	38	13 — 9	54	333	54	24 — 12	37
129	18	6 — 1	43	231	28	4 + 2	66	336	42	12 — 4	24
133	38	6 + 7	49	234	54	12 — 2	39	342	54	12 — 4	38
138	18	6 — 2	46	238	34	30 — 35	49	345	46	13 — 5	30
141	47	29 — 6	18	246	41	34 — 36	54	348	58	26 — 6	18
147	39	13 — 3	49	252	18	2 + 2	42	351	54	2 + 3	39
153	54	3 + 7	34					357	42	1 + 3	34

For example: To secure 51 divisions, we first move 28 holes on the 42 circle and 4 holes on the 34 circle, both movements being made to the right. This gives us

$$\frac{28}{42} + \frac{4}{34} = \frac{1120}{1428}$$

of one revolution of the worm and, since the ratio of the worm to the worm wheel is 1 to 40, we have

$$\frac{1}{40} \times \frac{1120}{1428} = \frac{1}{51}$$

of a revolution of the spindle.

For an example of the second case: Suppose that we wish to obtain 69 divisions, we would first move to the right 16 holes on the 24 circle and then to the left 4 holes on the 46 circle. This gives us $\frac{16}{24} - \frac{4}{46} \times \frac{1}{40} = \frac{1}{69}$ of a revolution of the spindle.

In executing movements to the left, pass the required hole then turn to the right to the proper hole. This avoids errors caused by back-lash in the worm gear.

Chicago, Ill. ROBERT A. LACHMANN.

SENSITIVE ATTACHMENT FOR MEASURING INSTRUMENTS.

Editor MACHINERY:

I have often wondered why the system of sensitive measurement such as is found on a Bath indicator is not more extensively used. No matter how finely and accurately micrometers and verniers may be made, dependence must in all cases be placed on the sensitiveness of a man's hand to obtain the exact dimensions of the piece to be measured. In order to overcome this difficulty and eliminate the personal equation in the manufacture of duplicate and interchangeable parts, I have tried the sensitive attachment to the micrometer shown in Fig. 1 and found it of much value.

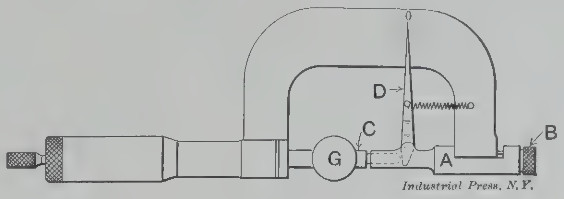


Fig. 1. Sensitive Attachment applied to the Micrometer.

The auxiliary barrel *A* is held to the anvil of the micrometer by means of a thumb screw *B*. In the inside end of the barrel is a secondary anvil *C*, the base of which bears against the short arm of the indicating lever *D*. The action will be clearly seen by reference to the cut. The micrometer is so set that when a gage, *G*, of exact size is placed between the measuring points the long arm of the indicator stands at the 0 mark. If the pieces being calipered vary in the least from the standard size it will be readily noted by the movement of the pointer. Hard rubber spheres turned from rough casting were found to vary from 3 to 5 thousandths after having passed the inspector's test with an ordinary micrometer. With this attachment the inspector's helper could detect very minute variations from the limit size. The same device was used to gage the size of small brass disks about half the diameter of the rubber spheres, and in fact anything within the limits of the micrometer can be made to show to the naked eye variations as small as a ten thousandth.

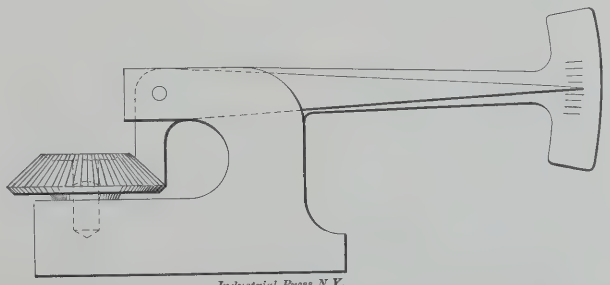


Fig. 2. Sensitive Attachment applied to Gaging Bevel Gear Blanks.

Considerable trouble was experienced with a pair of small brass miters because of the difficulty of getting the outside diameter just right. Inasmuch as they were finished on a screw machine some of the holes were not concentric with the face, causing the gears to bind. Fig. 2 shows a gage which was quite inexpensive and at the same time showed up the slightest inaccuracy. I have given only two ways in which this sensitive idea may be applied and I am sure that a wider field of application will suggest itself as its merits become more appreciated. H. J. Bachmann.

New York, N. Y.

VALVE AND PISTON MOVEMENTS.

Editor Machinery:

The following article contains some rather peculiar and interesting facts regarding the valve and piston movements of a compound pumping engine, where the center of the flywheel is considerably above the center line of the crosshead.

The pump, as originally constructed, had a 32-inch steam and a 26-inch water cylinder with a 48-inch stroke, and made 23 double strokes per minute. It was equipped with steam operated piston valves. There were two pumps of this size and style placed side by side. These pumps were straight line, direct acting and did not have any flywheel, therefore, of course, the steam was not used expansively. The indicator card showed almost the same pressure when exhausting, as the initial pressure of the steam entering the cylinder. The pumps were supplied with high-pressure steam which had to be wire-drawn at the throttle to prevent too high speed. It can easily be seen from the foregoing statements that the pumps were not of the most efficient type. It was proposed, therefore, that the pumps be tandem compounded, duplexed, and a flywheel added—which was eventually done—and just here considerable trouble was experienced due to lack of room. The pumps were placed very close together and could not be moved. The diameter of the flywheel was limited by lack of head room and various other parts of the construction were also affected by lack of room, as will be seen later. After compounding, the steam cylinders were 22 inches and 40 inches in diameter. The stroke and the water cylinder were left the same as before. There were two flywheels each 12 feet in diameter but these two were not large enough for a very short cut off, but still answered the purpose very well.

Now, with these few words of explanation regarding the conditions which limited our construction I will proceed with the conditions which we found; presenting a couple of sketches to make clear the explanation. While the conditions here presented are not new, still I know of no other case of an engine in which the conditions are so exaggerated. Of course the case is frequently met, in the Westinghouse engines for instance, where the centers of flywheel and crosshead are not in line, but seldom to such an extent as here. Shaper heads are usually designed with a quick return, on the same principle, but there, there is no valve to contend with.

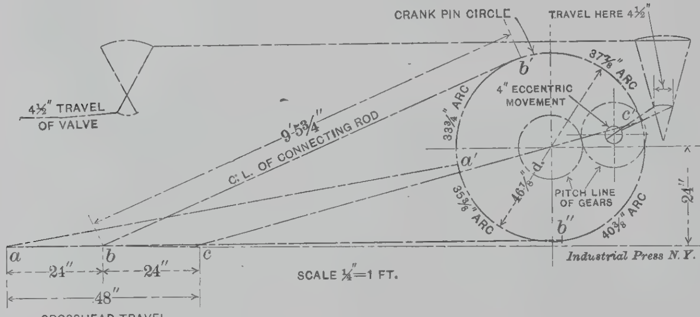


Fig. 1. First Arrangement.

As will be seen from the accompanying sketches, the travel of the crosshead is 48 inches, but the diameter of the crankpin circle is only 46⅞ inches. The length of connecting rod is 9 feet 5¾ inches, or a ratio of about 2½ to 1. The stroke of the valve, which was of the piston type, was 4½ inches.

Fig. 1 shows drawing as originally laid out and as the first model was made.

Fig. 2 shows the arrangement finally adopted.

Now starting the crosshead at a, which is the first dead center (and rotating crank pin in direction of arrow) when the crosshead reaches b, which is the first half of the out stroke, the crank pin will be at b',or will have traversed an arc of nearly 33¾ inches. While the crosshead travels the second half of the out stroke from b to c, the crank pin traverses an arc from b' to c', or nearly 37⅞ inches. During the first half of the in stroke the crosshead travels from c to b while the crank pin travels from c' to b'' or an arc of nearly 40⅜ inches. While during the last half of the in stroke the crosshead travels from b to a while the crankpin travels from b'' to a' or an arc of nearly 35⅜ inches. Now from these figures it can be seen that, with the fly wheel circumferential speed, or crank pin speed, remaining constant, the piston speed must vary considerably for each quarter and also for each half of the full double stroke. In fact the actual mean piston speed for each quarter of the stroke is as follows:

1st quarter from a' to b' is 192.1 feet per minute.
2nd quarter from b' to c' is 171.2 feet per minute.
3rd quarter from c' to b'' is 160.6 feet per minute.
4th quarter from b'' to a' is 183.3 feet per minute.

Thus the first quarter of the stroke is nearly 20 per cent. faster than the third quarter.

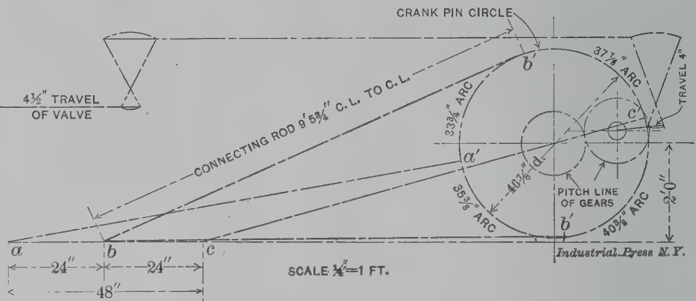


Fig. 2. Final Arrangement.

The eccentric which operated the valve could not be placed on the main shaft on account of the large diameter of the shaft and the lack of clearance room, so a gear was put on instead and this meshed with a similar gear on the eccentric shaft. The eccentric strap connected with a lever, which in turn operated a link, a lever, and another link until the valve was finally reached.

Now while the piston speed varied considerably, the valve speed was uniform because operated by the circumferential speed. Of course under these conditions no satisfactory kind of indicator card could be obtained, for when the lead and compression of both ends were equal there was 7 15-16 inches difference in the cut-offs, and the results were *vice versa* when the lengths of cut-off were equal.

To overcome this difficulty two methods were suggested, one, of making the angle between the eccentric strap center line and a horizontal line equal to the angle between the connecting rod center line and a horizontal line; also of making the ratio of the length of eccentric strap to the throw of the eccentric equal to the ratio of the length of connecting rod to the diameter of crank pin travel. By this method it was intended to make the speed of the valve directly proportional to the speed of the piston at all points.

The other method was to make cam gears to operate the eccentric. These cams were to be so shaped that the same result would be obtained.

The former method was chosen as being the more practicable and more likely to give satisfactory results.

A drawing was made and from the drawing a model, which made the piston and valve speed proportional at all points of the stroke, using the proportions explained above, when piston and valve started together from dead center; but when the advance was given to the valve, the first, or fastest, quarter travel of the valve was thrown so far ahead of the piston that the results were still poor. After changing the angle a few times, by trial, between the center line of eccentric strap and a horizontal line, the desired result was obtained as shown in Fig. 2.

These two pumps were duplexed and connected at an angle of 90 degrees, which produces the following conditions. When the crosshead of No. 1 pump is at a the crosshead of No. 2 pump is beyond b because the crank pin has an advance of 90 degrees or has traveled an arc of about 36 13-16 inches. When the crosshead of No. 1 pump has reached b the crosshead of No. 2 pump is not quite to c, because the second arc from b' to c' is more than 36 13-16 inches. During the third quarter of the revolution the piston of No. 1 pump still further gains on No. 2, but in the fourth quarter the reverse condition holds. This then presents a condition in which there is a never-ending alternate increase and decrease of distance between the two pistons, or for one-half the revolution there is less than a half stroke between the pistons and for the other half of the revolution there is more than a half stroke between them.

This, however, does not materially affect the efficient running of the pump. H. H. D.

DIES USING RUBBER AS AN AGENT FOR FORMING DIFFICULT SHAPES.

Editor MACHINERY:

The piece which is made by the dies herein described is used as a screw cap for cans, bottles, etc., and is a typical illustration of the class of work for which these dies are fitted.

Different manufacturers of such goods have different methods for rapidly producing formed blanks of this character. In some factories wax is used as an agent for forming blanks by first filling the cup-shaped blank with melted wax, and then placing under pressure. But the use of wax necessitates melting, after blank has been formed in order that the wax may be removed. Another method is to draw the blank to a cup shape and then roll the thread on, which is a very economical way where there is no bead on top of the blank.

The dies described in this article were constructed to use rubber for forming the blank and proved to be very satisfactory.

The first step in the production of the screw cap is to determine the proper diameter to make the blanking punch and die. If a formed blank is furnished as a model, then the die maker may determine the proper diameter of blanking die, by scribing a circle with a pair of dividers on a piece of sheet metal the exact thickness and of same material as the model. The circular piece is then cut out, and by carefully reducing diameter until it balances exactly with model, he may then proceed to make blanking die of same diameter as the round piece cut from the sheet metal. It is necessary that the balance scales used be very accurate.

When a bottle or can is furnished as model, then the die maker must depend largely upon former experience and also the familiar method of "cut and try." For cheaply producing any style of drawn work, a double-action press is used when possible. The shaft of such a press has two cranks or eccentrics so arranged that as the blanking punch starts on the upward stroke, after punching out a blank, the drawing punch descends through center of blanking punch and forces blank through the drawing die, which is in the center of the blanking die. This arrangement will be clearly understood by referring to Fig. 2. The edges of drawing die are well rounded, and the end of drawing punch is made on the same radius as the top of the model, and same diameter as the inside. The blank, of course, takes same shape as drawing punch, thereby lessening the amount of work for the rubber to perform.

In "setting up" a drawing die, the essential point lies in having the blanking punch "iron the blank." In other words the press is so adjusted that blanking punch presses the blank firmly at bottom of die at *S*, Fig. 2; otherwise the blanks will not draw evenly, or be of a uniform height. The stock is well oiled with a lubricant consisting of ¾ parts of pure lard oil and ¼ of soft soap thoroughly mixed. The blanks as they appear after passing through drawing die are shown at *A*, Fig. 1. They are then placed on a revolving lathe spindle that has been turned to exactly fit them on the inside. The tail spindle is turned to conform with outside end and is so constructed that when brought to bear on blank by means of a lever, the friction causes the tail spindle to revolve. The lever end of tail spindle has a ball or knob turned thereon, that runs in a ball bearing seat to reduce friction. An ordinary knurl, straight across the face, is then brought to bear upon the blanks, and it is knurled as shown at *B*, Fig. 1.

The first thing to be considered in constructing the forming die is the selection of a rigid, powerful press as it requires quite a little power to force metal. Having decided upon the press, a cast iron bolster, *B*, is made. This is shown, with the dies in place, in Fig. 4. It should have all bearing surface possible upon the bed of press, and be as thick as stroke of press and length of punch will allow. It is planed on the bottom and the dovetail on top in which the dies slide, great care being exercised to have the angular sides parallel. A hole is drilled at *C* for the adjusting screw and holes are drilled and tapped for the set screws *AA* to fasten securely one half of die and to adjust the gib for the other half. The next step is making the dies. They are made in halves as shown in Fig. 3. The steel is selected of a high grade and properly annealed. They are then planed all over to within 1-32 inch of finish size and annealed again. Annealing after scale has been removed is to remove, as far as possible, the strain that must be in the steel, and the probability of their changing during hardening, is much lessened. The dies are then planed to required size, and beveled to fit the bolster, allowance being made for the gib. One half of the die is drilled and counterbored at *C*, for the lever hinge which is shown in place in Fig. 4. A holder or sub-bolster is then made to hold dies securely while they are being turned in the lathe. The dies are then placed in this holder and fastened by means of set screws.

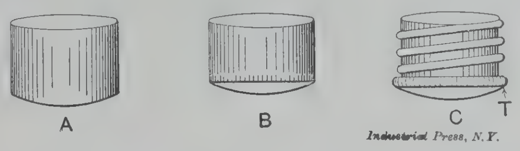


Fig. 1. A, The Blank. B, The Blank after Knurling. C, The Completed Cap.

The line where two halves meet is carefully prick punched in center of dies. The proper pitch of model is then ascertained by dividing 1 inch by the distance from center of one thread to the center of next. A templet is filed to the shape of thread and an inside thread tool made to match the templet.

The holder, or sub-bolster, is fastened to faceplate, the dies "wriggled up" by prick punch mark, and a hole bored the same diameter as inside of blank, ¾ inch deeper than length of model. The bottom of hole is turned the same radius as the model. Then, starting ¾ inch below surface of die, the hole is enlarged to diameter of outside of blank *B*, Fig. 2. The lathe is then geared to cut proper pitch, the thread is chased and the recess is bored for the bead *T*, Fig. 1. By leaving the hole at top of die the same diameter as inside of blank, the edges of the blank are prevented from cutting the rubber, besides allowing a tight fit for the punch, thereby positively confining the rubber.

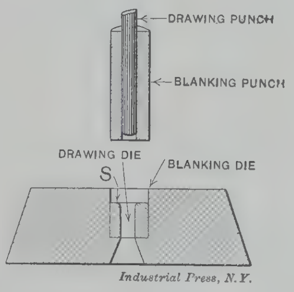


Fig. 2. Section through Double Action Press.

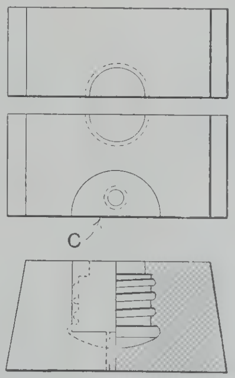


Fig. 3. The Die used in Forming the Cap.

The impression in the die is well polished, as the tool marks will show on blank if they are left as turned. The bolster or holder is then removed from lathe and without disturbing the dies, the impression is poured full of babbitt, after having been first treated with a light coating of graphite to prevent the babbitt from sticking. When thoroughly cool the dies are removed from the holder and the babbitt taken from impression and laid aside for the time being. A piece of rubber such as is used for wagon springs is turned or shaped to fit inside of the blank, sufficiently free to allow it to be easily inserted and removed and of a length that reaches nearly to top surface of dies when it is placed in the blank in the die.

Before hardening, the dies are placed in the bolster, the half *P*, Fig. 4, is fastened securely by means of the set screws and the half *R* is adjusted by means of gib and set screws so that it slides freely when moved by the lever.

The dies are then closed and the lever hinge *I* adjusted so that when the dies are together, the two parts of the joint *G* will be in a straight line, thus preventing the dies from opening when under pressure. This adjustment is accomplished by the screw *E* which is retained in its position by the check nuts, *F F*. The dies are then ready to be aligned with the punch.

In aligning the die and punch, the ram of press which holds the punch is lowered until punch nearly touches the die. The bolster is then raised by placing a substantial stick of wood up through bed of press, and lifting bolster with knee, using both hands to guide it. When the punch enters the die, the ram is lowered until bolster rests on bed of press, in which position it is firmly fastened. By pulling over the lever the dies are opened. A knurled blank, containing the piece of rubber, is now inserted and the dies closed. The rubber does not compress, when under pressure, so when the punch descends upon it the metal is forced out where not supported by the dies. When the punch ascends, the rubber returns to its original shape and is easily removed from the finished blank.

One or two blanks are formed while the dies are soft, to prove that they are correct, after which they are hardened. To get best results they are packed in a crucible, using ground bone to exclude air and insure an even heat. The degree to which they are heated will depend upon the quality of the steel, and the die maker must, therefore, be familiar with the grade of steel used. When the proper heat has been attained, the dies are immersed one at a time in a bath of clear water previously warmed. They should be held in one place, as the swashing back and forth tends to cause them to warp. As soon as the hand can be borne against the dies in the bath, they are removed, polished with emery cloth and placed at one side of fire on hot ashes until the proper color denoting temper appears. It is customary with a great many tool makers to constantly wipe the face of the die with oily waste while drawing temper. But it is not good practice, as the oil burns on die, and produces a deep straw color; and when die is cool, that same color can easily be wiped off. Therefore it is better not to put anything on die that is liable to produce a false temper. After hardening, the dies are soldered together, using the babbitt mold to keep them in line, and ground first on the bottom, then the beveled sides, and lastly the top. The faces where the two halves come together are lapped to insure a perfect joint. The dies may now be replaced in the bolster and, having been adjusted as before, are then ready for operation.

Frank E. Shailor.

New Haven, Ct.

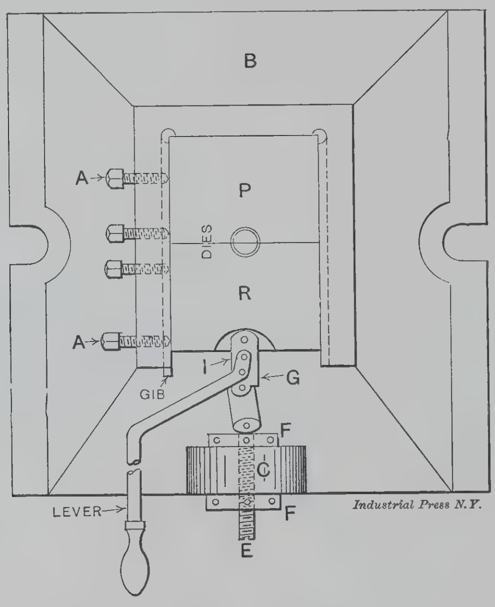


Fig. 4. The Dies in Position in the Bolster.

CLASSIFICATION OF MACHINERY AT THE ST. LOUIS EXPOSITION.

As far as now determined, the exhibits of machinery at St. Louis will be grouped under five headings, as follows: Prime Movers; Transmission of Power; General Machinery; Machine Tools; Arsenal Tools. It is not stated in the information at hand whether the section "General Machinery" will include agricultural machinery, printing machinery, typewriters, automobiles, and other lines not specified above, or whether these will be displayed in other departments of the exposition. The information so far furnished is as follows:

Prime Movers.—The generation of power from steam will be shown by the operation of all the items which go to make up a complete plant. This will include boilers and their accessories in operation, such as appliances for boiler feeding, water purifiers, fuel economizers, superheaters, chimneys, smoke consumers, grate bars, flue cleaners. The appliances for the transmission of steam, which include systems of steam piping, joints, gaskets, valves, traps, separators, condensers, etc., will lead to the prime movers using steam. Every type of steam engine, whether stationary or portable, reciprocating or rotary, will be included, together with such parts as may need special mention, such as valve gears, governors, and apparatus for lubrication. To this group will be added all other vapor engines, hydraulic motors, and the apparatus for testing the above machines. These latter will include turbines, water wheels of the tangential type, water pressure engines, etc.; gas engines and the kindred types of petroleum, carbonic acid gas, alcohol and compressed air motors; also the parts and fittings for such machines, and various other motors not specified.

Transmission of Power.—Such appliances as are essential to the transmission of power, and go to make up the last factor in the development and use of power. Under this head will be found shafting, pulleys, belts, cables, lubricators, etc., while in the proper delivery of the power thus generated will naturally be associated such apparatus as is necessary to record its performance. Thus we will find here, counters, speed indicators, dynamometers, weighing machines, testing machines, etc.

General Machinery.—Machines for moving heavy bodies, including cranes, hoists, conveyors, etc., all machines for raising water, such as pumps, hydraulic rams, and systems of piping for gas, water and air. Ventilators and blowers will be included in this group. To it will also be added fire engines, hose, and all apparatus used by firemen.

Machine Tools.—Machines for working in metal and wood will be included in this classification. In this section will be found steam hammers, machines for punching, shearing, etc., methods for working metals and the tools used in connection with these processes. Automatic machine tools, and all machines with cutting tools, such as planers, millers, drills, lathes, etc., together with such machines as are used for grinding and polishing will also be exhibited here.

Hand and hand with the advancement in metal working machinery are machines for working in wood. These include machines for sawing, planing, turning, etc., for polishing and veneering, and special machines, such as nailing, box and basket making machinery. To these classes will be added such hand tools as are essential in their manufacture, including vises, files, taps, dies, knives, graving tools, etc.

Arsenal Tools.—The increasing perfection in the world's armament and the improvements in all kinds of firearms, have brought with them the necessity for special tools, and methods of shop practice. That these facts may be recognized, these machines have been set apart in a special grouping known as "Arsenal Tools." This will include machines for forging, milling, polishing, etc., in the manufacture of guns and different arms. Also tools for the manufacture of cartridges and ammunition for both military and sportsmen's use.

* * *

According to *Poor's Manual* for 1902 the total railroad mileage in the United States on December 31, 1901, was 198,787 miles, or practically now 200,000 miles. One-half this mileage has been built since 1882.

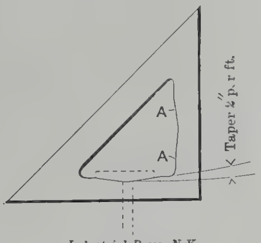
CONTRIBUTED NOTES AND SHOP KINKS.

SCALES WITH 1-100 GRADUATIONS.

X. Y. Z., Richmond, Va., writes: Many mechanics when they buy new scales still buy those without any tenths or hundredths graduation. All the principal manufacturers of scales make them and sell them at the same price as the old timers. Every up-to-date shop is using the decimal system in laying out work. It may therefore be well for apprentices and other mechanics who need new scales to buy the tempered ones with the 1-100th graduations along with the 1-16, 1-32 and 1-64 graduations; that is if they are not decided which to get.

A TRIANGLE KINK.

P. P. P. sends a drafting room kink which should prove of convenience to anyone engaged in structural drafting. Cut out the inner edges of the triangle to a taper of 2 inches per foot, as shown at *A*, *A*. This gives the proper angle for the taper of flanges of I-beams and channels.

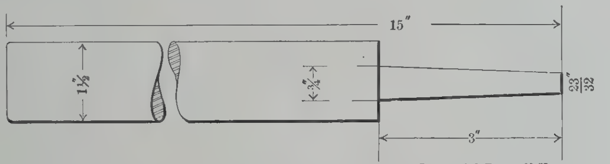


Industrial Press, N.Y.

SETTING THE HEADSTOCK FOR TAPER.

W. H. N., Chicago, Ill., sends the following kink in regard to turning a taper by setting over the headstock:

I had occasion to turn the taper shank shown below and not liking the usual cut and try method of doing the job I figured out the required set-over as follows: The difference in diameter is seen to be 1-32 inch in 3 inches, equal to an axial taper of 1-64 inch. For a total length of 15 inches this would be 15-3 × 1-64 = 5-64. This is the amount that the tailstock must be set over.



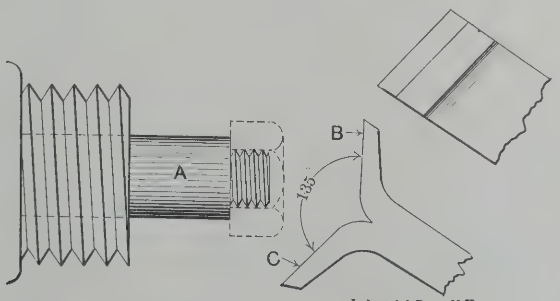
Industrial Press, N.Y.

Now the set-over screw had 12 threads per inch, so to give an advance of 5-64 inch it must be given 5-64 ÷ 1-12 times = 60-64 or 15-16 of a turn.

By putting a line on the side of the setscrew I was able to estimate the 15-16 of a turn very nearly, so that after the trial cut, the adjustment had to be altered but very little.

TOOL FOR FACING AND CHAMFERING NUTS.

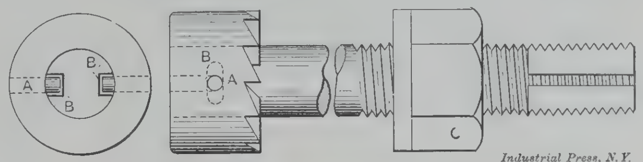
G. M. Strombeck, Moline, Ill., sends a sketch of a tool that he uses for facing and chamfering nuts in the lathe. The arbor *A* fits the hole in the end of the lathe spindle, and has a short thread at its outer end onto which the nut is screwed, as shown by the dotted lines. The tool has two cutting edges, *B* and *C* which make an angle of 135 degrees with each other. The nut is first faced with the edge *B*, and then chamfered with the edge *C*, after which it is removed, turned around and the bottom finished with the edge *B*, this completing the operation.



Industrial Press N.Y.

A BACK-FACING BAR.

Mr. Fred. Harrison, Philadelphia, Pa., sends us the sketch of a back-facing bar which, he claims, is a great improvement on the ordinary facing bar with a double cutter that is continually breaking. The object of this cutter is to do away with the keys which, in the old-style bar, are used to hold the cutter up. A rose milling cutter, after being hardened is fitted with the pins *A A*, while the end of the bar is fitted with slots *B B* for the reception of these pins. By this arrangement it is necessary only to slip the cutter on the end of the bar when a slight turn locks it securely in place. When the work is completed the cutter is simply turned forward and slid from the end of the bar.



Industrial Press, N.Y.

A nut *C* provides for feeding the cutter up to the link. The upper end of the bar is made square for the reception of a wrench, or it may be made tapering and the bar driven by power.

SPECIAL LATHE DOG.

C. D. King, Brooklyn, N. Y., sends us a "kink" that he has used for turning pieces having a square head, as shown in Fig. 1, but which will be found equally convenient for turning bolts or anything of a similar shape. It consists of the sheet steel piece *A* which is bolted to the faceplate, as shown in Fig. 2. In this strap is a slot through which the head of the bolt is passed when it is put onto the lathe center. The sides of the slot serve to drive the work, thus dispensing with the use of a lathe dog.

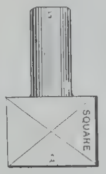


Fig. 1

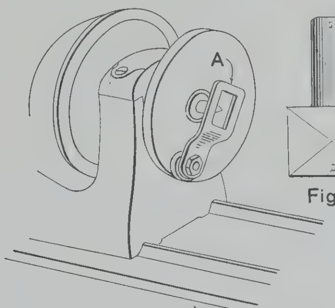
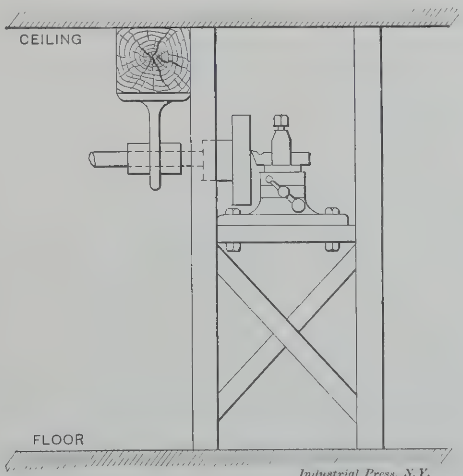


Fig. 2

Industrial Press, N.Y.

HOW A FLANGE COUPLING WAS REPAIRED.

R. H. Hampson, Anniston, Ala., sends us an account of a rather ingenious repair job which he recently performed. The coupling of a jack-shaft had become loose and it was desired to replace it. As the shaft was seven inches in diameter and the pulleys were keyed on solidly, it would have been a very long and expensive job to have removed them in order to turn the shaft in a lathe; so the work was ac-



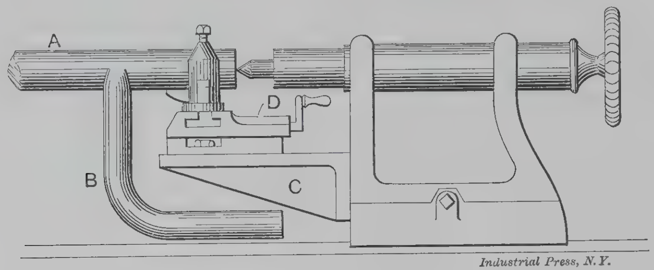
Industrial Press, N.Y.

complished in the very simple manner shown in the sketch. Four pieces of 2x4 inch timber were securely fastened to both floor and ceiling and firmly cross-braced. At the proper height a platform was constructed, upon which was mounted a carriage taken from a lathe. The old coupling having been removed, the engine was run slowly and the shaft returned. The new coupling was then shrunk on and faced off in the same manner that the shaft had been turned.

TURNING AN AWKWARD SHAFT.

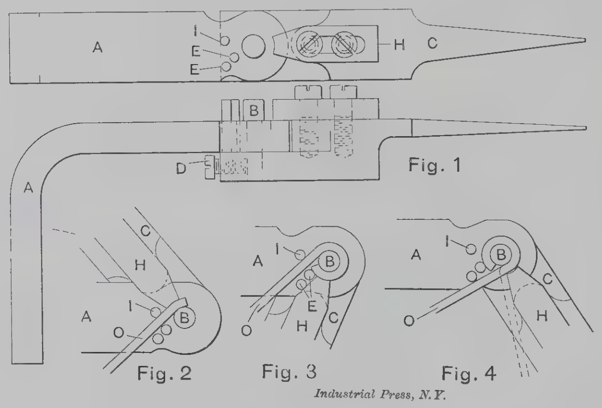
G. F. H. sends us the following:

The shaft shown in the figure was recently brought into the shop to have its journals re-turned, as they were badly worn. The curved arm, *B*, extended 6 inches beyond the end of the shaft, and when we had placed the shaft in the center of our 48-inch lathe we found we had not sufficient room to operate the lathe carriage. Finally we clamped the angle plate *C* to the front side of the tailstock and on this mounted the tool rest taken from a small lathe, as shown at *D*. Although we were obliged to feed this carriage by hand, we were able to do a very satisfactory job with this arrangement.



TOOL FOR BENDING EYES AND HOOKS.

C. D. King, Brooklyn, N. Y., describes a device which he recently made for bending eyes and hooks from wire. It consists of the angle piece *A* and the bending lever *C*. When in use, the angle piece is clamped by its lower end in a vise, shown by the dotted lines in Fig. 1. The bending lever is pivoted about the pin *B*, which is held in place by the set screw *D*. The pins *E*, *E* and *I*, are driven into the upper end of the angle piece *A*, which is cut away on either side to give sufficient swing for the lever *C*. This lever has a tang on which is driven a wooden handle, not shown, by which the fixture is operated, while on top is fastened, by two screws, the slotted movable finger *H*, which is adjusted for various sizes of eyes and wire.



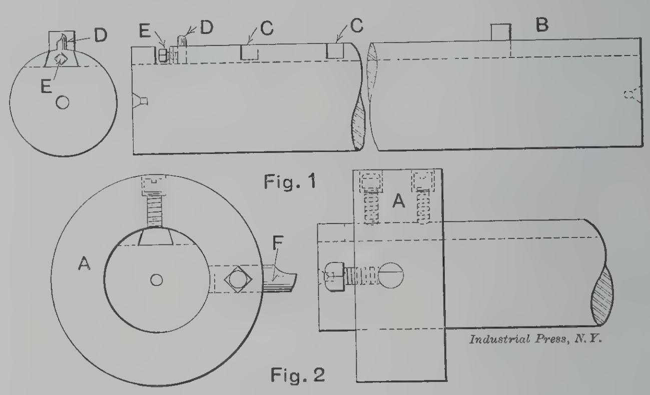
Hook and Eye Forming Tool.

The process of bending is as follows: The straight piece of wire *O*, Fig. 2, is slipped in between the pin *B* and the finger *H*, after the handle *C* has been brought to the starting position, as shown. *C* is now moved clockwise until it comes to the position shown in Fig. 3, and cannot go any farther as the finger *H* comes against the pins *E* and *E*. In these operations the pin *B* turns with the finger *H*, the wire being pinched between them by the bending action of the pin *I*, and the eye is completed all but giving a radial bend. It is now reversed, as seen in Fig. 4, and a small movement of the part *C* toward the left brings the stem *O* radial with the ring as indicated in dotted lines.

Several sizes of former pins *B* will be required for various sizes of eyes.

A CONVENIENT BORING BAR.

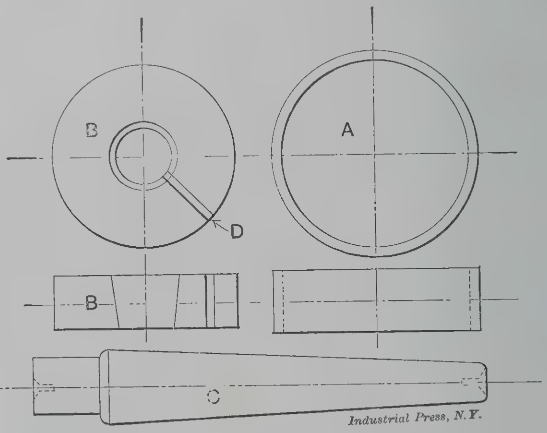
Those who occasionally have a small job of boring to do in the lathe will find such a bar as is described by W. W. Cowles, Waterbury, Conn., to be very practical and convenient. This bar is made from cold-rolled steel of any diameter and length, depending upon the work to be done. A dovetail slot is planed the entire length of the bar and fitted with the sliding rod, one end of which is turned up as shown at *B*, while the other end is drilled for the tool *D* that is held in place by the setscrew *E*. In boring out a long hole, where the work can be revolved by the face-plate and supported at the outer end by the center rest, the bar is placed on the lathe centers and prevented from turning by a dog against the tailstock. A tool is placed in the tool-post and the carriage run up until the tool strikes the lug *B*. By throwing in the feed the bar will now be pushed through the piece to be bored. Slots *C C* will have to be cut in the bar at intervals so that a wrench can be used on the set screw in the end of the feed rod. For boring larger holes the collar *A* is slipped over the bar and fastened to the feed rod by two screws as shown in Fig. 2. The cutter is then fastened in the collar as at *F*.



A Simple Boring Bar.

TURNING PISTON RINGS.

"Student" sends a "kink" which he has used for turning the outside of piston rings. The rings, shown at *A*, are first roughed out in a turret lathe and bored to the required inside diameter. The outside turning and facing off of the ends is done on the expanding head *B*. This head is bored to fit the taper arbor *C* and turned to fit loosely the bore of the rings. It is made narrow enough so that the ends of the rings project on either side. The ring is slipped onto the head and the taper arbor forced into the hole. The slot *D* in the head allows it to expand and firmly clamp the ring which is then finished in the lathe.



Rig for Turning Piston Rings.

* * *

In boring long cast iron tubes, say 16 inches in diameter, excellent results have been obtained by the use of kerosene as a lubricating agent. The holes were bored with a "packed bit," of the type used for gun boring and were finished as smooth as glass.

ITEMS OF MECHANICAL INTEREST.

LARGEST PULLEY BUILT—READING VERNIER CALIPERS—A TAKE-UP DEVICE FOR INDICATORS—NEW BELT LAW—HYDRAULIC BEAM SHEAR.

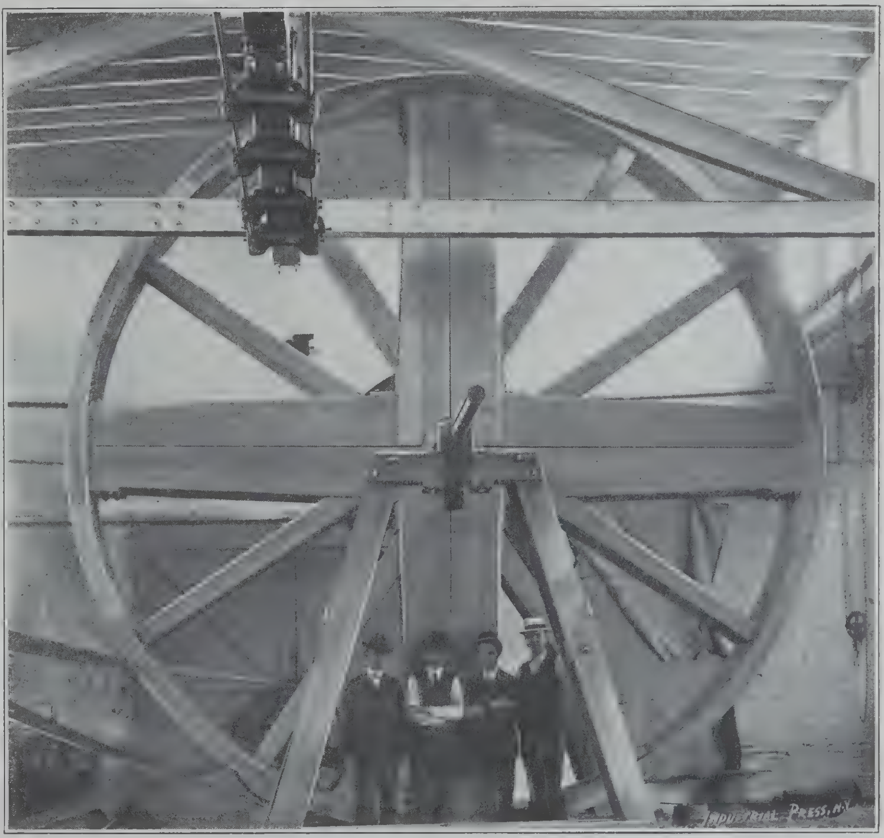
The *Canadian Electrical News* quotes a curious circumstance illustrating the difference in speed between sound, which travels through the air, and electricity through wire as its guide and conductor, that occurred in California. A certain powder works blew up in a town while a railway telegraph operator was telegraphing to another in a neighboring town. At the instant of the occurrence he telegraphed the news to the operator, who, sixty seconds afterward heard the report of the explosion. He knew it had occurred by wire just one minute before he heard the report. Sound travels at about the rate of 1,140 feet per second, while electricity accomplishes 186,000 miles in the same short period of time.

One of the changes likely to be made by the general use of electric power, is the displacement of the steam fire engine by the electric motor pump. Already in France the electric fire pump has been tried with success, being much lighter to handle and quicker to get into operation. One horse draws the pump to the fire and connection is made with the street car line circuit. The moment connection is made the pump is ready for business, and expense for power ceases the moment the current is shut off. If such a system of fire protection was developed for a city it would probably be that each fire hydrant would also be an electric "hydrant" having a socket for connecting the wires leading to the motor driving the pump. The system of electric mains could be laid underground and parallel with the water mains, where they would be reasonably secure from accidents.

A correspondent of the *Scientific American* suggests that calcium carbide may be used for quickly obtaining heavy pressures and that it might be made useful for baling cotton, hay, straw, and for many other kinds of work where heavy pressure is required for brief intervals of time. Its merit would lie in the simplicity of the apparatus. He has experimented with a four-foot steel pipe capped at one end and provided with a cap and stuffing box at the other end, through which a turned shaft was inserted carrying at its lower end a basket for the carbide. A release cock and gage reading to 400 pounds were also provided. The pipe was filled with water to a depth of six or eight inches. On lowering the carbide basket to the water and forcing the air out of the pipe, a second quick plunge forced the gage around to 400 pounds in three seconds.

A labor-saving device of the first order is a hydraulic tire setting machine for wagon wheels. The ordinary process of taking the tire off the wheel, cutting out a section, and welding the ends together, as followed by many blacksmith shops, takes considerable time and labor and is usually an unsatisfactory job in a number of ways. The distance between the bolt holes that straddle the weld is shortened, and unless the blacksmith is quite skillful the wheel is likely to be "dished" too much. With steel tires there is also the difficulty of getting perfect welds. To be sure there are tire upsetting machines which shorten the tire circumference without cutting and welding, but these require the tires to be removed from the wheels. The device referred to consists of a horizontal frame carrying, say, fourteen plungers attached to the inside of a strong circular ring and all pointing toward the center. The wheel with the tire in place is laid in the center of the ring so that the plungers bear on the tire. Then all are forced inward at the same time with a water pressure that may be carried up to 2,500 pounds per square inch. The amount the tire is shortened is under perfect control and consequently the amount of "dish." No dismantling or heating whatever is necessary. It is claimed that a tire can be set in one minute.

The use of graphite in soft paste form for lubricating bicycle and automobile chains, is by no means new, but its use in the form of cakes having a moderately high melting temperature, is comparatively so. Chain graphite is prepared in this form, by the Dixon Company, that requires a temperature of about 180 degrees F. to melt and it is to be applied to the chains while hot. It is melted in a shallow pan large enough to contain the chain coiled in a close spiral. The chain (which should be well-cleaned) is dipped and allowed to remain for some several minutes. This gives time for the air around the joints to escape and allows the graphite to penetrate to all the working parts. The advantages of chain graphite prepared in this manner, are that it forms a solid bushing around each rivet that is not easily displaced, and that it does not attract the dust and dirt of the highway.



Largest Wood Pulley ever Built.

A MONSTER WOOD PULLEY.

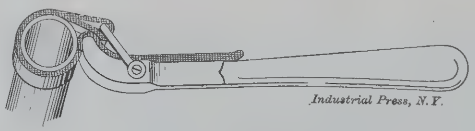
What is believed to be the largest wood pulley ever built was lately made by the Reeves Pulley Co., Columbus, Ind. This pulley, which is illustrated in the accompanying halftone, is 20 feet in diameter, has a face 30 inches wide, and is bored for an 18-inch shaft. Although larger than anything ever before attempted by the Reeves Co., this pulley was completed within 20 days from the time that the order was received. It was furnished to the Taunton-New Bedford Copper Co., New Bedford, Mass.

AN ELECTRIC WHIP.

While of no particular importance as an invention, a Georgia mail carrier has produced an electric whip which has the merit of novelty. He drove a letter carrier's wagon with doors that could be closed in case of rain. In stormy weather he naturally disliked to open one of the doors in order to reach out and apply the lash to his equine, which, being an intelligent animal, naturally took advantage of this situation and always lagged in rainy weather. To overcome this propensity the Georgia Edison attached a pair of copper plates under the harness saddle and connected them by wire to a hand operated dynamo in the wagon. When the steed began to jog up and down, without making much advance, it was time to turn the dynamo crank, which gave the horse a very evident wish to get over the ground more rapidly and almost any desired speed could be obtained, according to the number of rotations per minute given the dynamo armature. An apparatus is now contemplated, says the *Atlanta Constitution*, which paper has the distinction of first telling about this invention, for use on plows, whereby both the mule and plow hand shall be automatically shocked every few minutes. It is believed that such an attachment would find a tremendous sale all over the south, as by its use farmers could be very sure that no darkey would go to sleep between the plow handles.

WRENCH FOR SMOOTH PIPE AND TUBING.

The wrench shown in the cut has recently been brought out for use on polished pipes and tubing, where the scratches caused by the use of an ordinary wrench would mar the appearance of the pipes, or perhaps, of the entire machine. The canvas strap is passed around the pipe and held firmly by the pressure of the toe of the wrench, thus securely gripping the pipe without bringing any metallic part of the wrench in contact with the polished surface. The simple ratchet movement by which the wrench is operated, renders it especially convenient for use in close quarters, while its wide range makes it equivalent to three sizes of ordinary wrenches. An 18-inch wrench is applicable to all sizes from 1 inch to 5 inches in diameter, while a smaller size takes all pipe 1 inch diameter and under. This wrench is made by the Warnock Mfg. Co., of Boston, Mass.

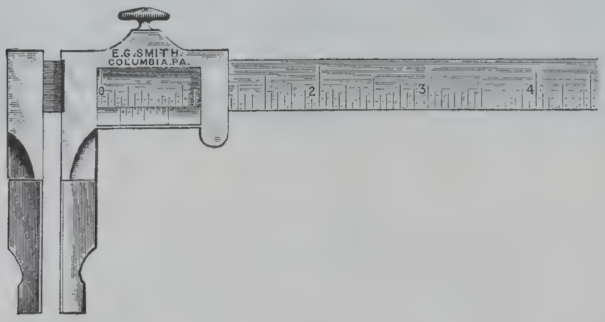


A Novel Pipe Wrench.

READING VERNIER CALIPERS.

The application of the vernier to beam calipers, for fine measurements, usually in thousandths, is familiar to most machinists. Less familiar, but equally convenient, is the use of the vernier for making the ordinary scale measurements in 16ths and sub-divisions thereof.

The cut shows a beam caliper with vernier slide, by the use of which measurements are made in 128ths of an inch. The beam is divided into 16ths of an inch, while a space of 7-16 on the vernier slide is divided into eight divisions, each one of which is consequently 1-128 inch less than 1-16. Now if the 0 line of the scale has passed a certain mark on the beam and the line at the right of the first space, on the scale, coincides with a line on the beam, then 1-128 inch must be added to the reading of the mark passed by the 0 line. If two spaces on the scale are passed before two lines correspond then 1-64 is added, and so on. In the cut it will be seen that the left hand, or 0 line, of the scale, has passed the ⅛ line on the beam and seven spaces on the scale have been passed before a line on both scale and beam coincides. Therefore 7-128 must be added to ⅛ to give the reading of the opening between the jaws of the caliper, that is 23-128 inch.



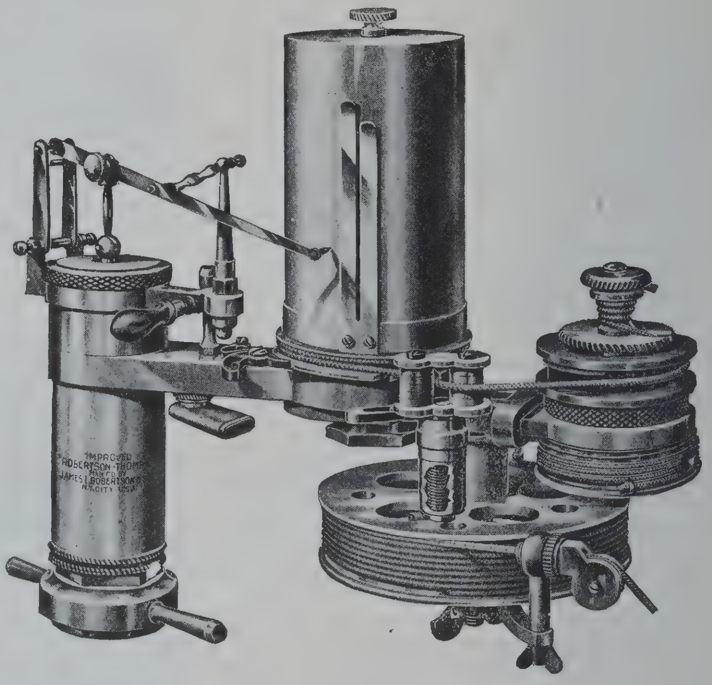
Vernier Caliper for Reading in 64ths and 128ths.

This method of graduating makes working to the ordinary scale dimensions a matter of much more accuracy than is possible with the use of the ordinary caliper and steel scale, besides being far easier on the eyes of the machinist. Calipers of the kind described are manufactured by E. G. Smith, Columbia, Pa.

A TAKE-UP DEVICE FOR USE IN CONNECTION WITH THE DETENT OF THE INDICATOR.

The majority of indicators in use at present are provided with a detent by means of which the paper drum is stopped and held stationary so that cards may be taken off and new ones put on without unhooking the cord from the crosshead. The great trouble that has been experienced in using the detent on the indicator has been caused by the slack of the cord between the drum and the reducing wheel. This slack, if not properly guided, is very likely to get fouled with some parts of the indicator and if the instrument is not wrecked the cord at least is broken, causing delay and inconvenience to the operator. In order to overcome this trouble a take-up device, which may be attached to any style of indicator, has lately been devised.

A short horizontal arm, which is fastened to the indicator, is provided at the outer end with a vertical bearing, at the upper end of which is a frame carrying two sets of steel rollers. Between these rollers passes the cord from the drum to the reducing wheel. On the lower end of the vertical bearing is a light enclosed spiral spring which causes the upper frame to revolve when the cord becomes slack as is the case when the detent is thrown in. The arrangement is such that as soon as the detent is thrown in, the cord from the reducing wheel, which ordinarily winds and unwinds from the barrel, is now automatically wound on the take-up frame while the barrel remains stationary. The spring in the take-up is so much weaker than that in the barrel that as soon as the detent is thrown out of action the cord immediately becomes taut between the drum and wheel and slides freely between the two sets of rollers on the vertical frame.



Indicator with Take-up Device.

The illustration shows the device as attached to one of the standard indicators. It is manufactured by James L. Robertson & Sons, New York.

A NEW BELT LAW.

The old law that the efficiency of a belt for transmission of power increases with its initial tension (to the limit of practical strain, of course) is so commonly accepted that the following results, directly opposed to that law, and which were sent us by the Cling-Surface Mfg. Co., Buffalo, N. Y., are of considerable mechanical interest.

Two new and identical 4-inch belts were used, leading from two similar 8-inch pulleys on the single shaft of a 10 horse power motor to two similar 12-inch pulleys on two similar generators. The centers were 8 feet. One belt had been treated with Cling-Surface, the other was as it came from the maker. A wattmeter was connected to each generator, and circuit and switches were arranged to throw full load on either generator. In the one case, intimate contact between belt and pulley was secured by the application of the Cling-Surface preparation and the tests showed that such a belt would not only run slack under full load, but would transmit more power when running slack than when running tight. This is due to the increased belt and pulley contact and great reduction of friction load. In the other case the frictional resistance between pulley and belt could be maintained only by increasing the tension and consequent normal pressure upon the pulley face, as the load increased. This resulted in increased friction load, and a reduction in the proportionate amount of power transmitted. The wattmeter readings were as follows:

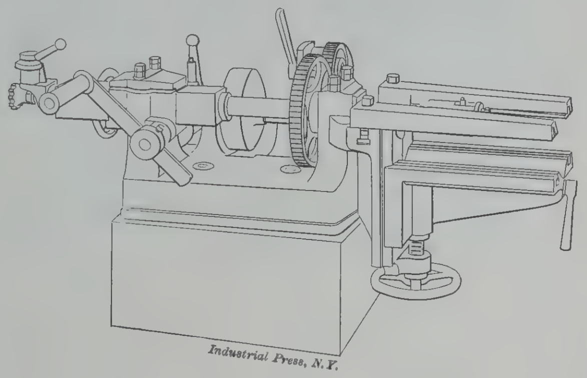

Industrial Press, N.Y.

Fig. 1. Machine for Cutting Oil Grooves.

Four-inch Belt with Cling-Surface.

At 54 pounds initial tension, transmitted 7 3-5 horse power.
At 40 pounds initial tension, transmitted 7 4-5 horse power.
At 30 pounds initial tension, transmitted 8 1-5 horse power.
At 20 pounds initial tension, transmitted 8 4-5 horse power.
At 15 pounds initial tension, transmitted 9 1-5 horse power.
At 10 pounds initial tension, transmitted 10 horse power.

At this point with 8½ pounds initial tension on the belt the slack was so great that there was only 2¾ inches between the upper and lower side of the belt in the center.

Four-inch Belt without Cling-Surface.

At 54 pounds initial tension, transmitted 7 3-5 horse power.
At 45 pounds initial tension, transmitted 6 horse power.
At 40 pounds initial tension, transmitted 5 1-5 horse power.
At 35 pounds initial tension, transmitted 4 3-5 horse power.
At 30 pounds initial tension, transmitted 4 horse power.

At 20 pounds initial tension, transmitted 3 2-5 horse power and there stopped. The belt here slipped around the pulley and would transmit no more power.

MACHINES FOR CUTTING OIL GROOVES.

Any machinist who has cut oil grooves in a long bushing with a hammer and chisel will be interested in the machine shown in Figs. 1 and 2, which is designed for doing this and similar kinds of oil groove cutting. Fig. 1 shows a general view of the machine, which is clamped to a bench in the same manner as a vise. The work is supported in a V rest which has an up-and-down adjustment operated by means of a handwheel. The tool is held in a bar and drawn through the hole in a manner similar to the action of a draw-cut shaper. By the provision of change gears, reversing gears and a friction clutch, it is possible to cut oil grooves straight, spiral, (right or left hand) or straight with spiral starting and ending. A micrometer feed and adjustable stop are provided for regulating the depth of the groove. The machine does better and more effective work than can be done by hand besides keeping collected together the chips that, when the work is done by hand, fly all over the shop. It is made by C. W. Burton, Griffiths & Co., Ludgate Square, London, E. C.

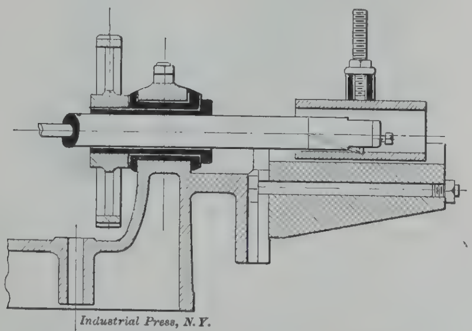
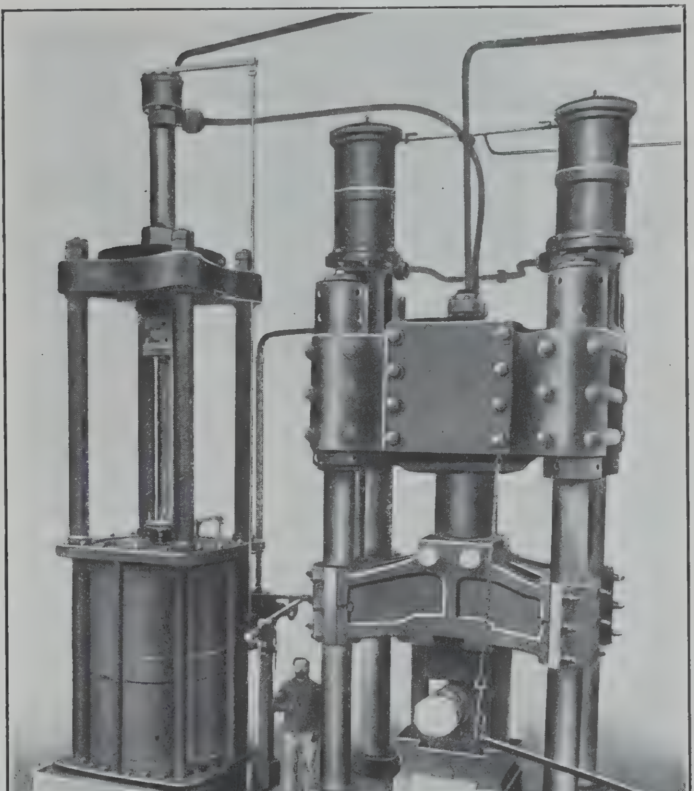

Industrial Press, N.Y.

Fig. 2. Cutting an Oil Groove in a Bushing.

ELECTRICALLY-OPERATED HYDRAULIC SHEAR.

Robert Grimshaw, Hanover, Germany, sends a photograph and brief description of an electric hydraulic beam shear, which in points of size and design is somewhat unusual. The machine consists of the shear proper and a pump driven by a 10 horse power electric motor. The shear has two cast-steel stands that are connected by a single steel casting which also forms the cylinder. The piston of the latter, which has leather packing, has at its lower end the tool-holder, which has side guides on the stand and receives in the best possible manner the side pressure unavoidable in shearing off beams of varying resistance. The lower guide prevents the tool from moving in a fore-and-aft direction. The stationary lower knife and the side knives are directly between the halves of the stand. These side knives may be adjusted by means of a spindle and hand wheel.


German Hydraulic Beam Shear.

After the bar has been cut off, water is admitted to the two reversing cylinders, shown at the top of the side columns. The pistons of these cylinders are connected with the sides of the tool holder and by them the shear is returned to cutting position. The water supply for both cylinders is controlled by valve gear on the side of the housing. The pressure pump, which is at the side of the machine, has a double piston. At first both pistons are in action, so as to expedite that part of the stroke where no work is being done; then, as soon as resistance is felt, one piston is thrown out and correspondingly higher pressure put on.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

COMBINATION TOOL FOR MACHINING STEAM ENGINE CYLINDERS AND FRAMES AT ONE SETTING.

One of the latest productions of the Beaman & Smith Co., Providence, R. I., is the combined milling and boring machine illustrated in Figs. 1 and 2. It is designed for machining small-sized engine frames of the type having cylinder, bedplate and crank-shaft bearing combined in one casting. Upon this machine these frames can be machined complete at one setting. A main boring spindle bores out the cylinder and faces it for the head, a milling cutter finishes the cross head guides, and a secondary boring spindle bores and faces the sides of the crank-shaft bearing.

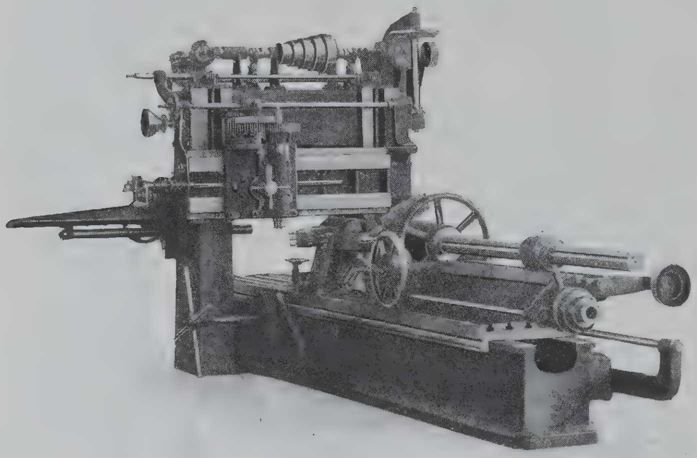


Fig. 1. Cylinder Machine, Front View.

The main boring spindle is 4 inches in diameter and is driven by a 3½-inch belt running on a five-section cone. A spindle speed of 20 feet per minute is suitable for boring cylinders from 4 to 19 inches in diameter. This spindle has a feed of 50 inches and will feed at the rate of 4, 6, 12, or 36 revolutions per inch of travel, in either direction. The facing capacity is from 4 inches to 24 inches in diameter and the tool feed, either in or out, is 1-30, 2-30, or 3-30 inch per revolution. Each facer has a fine adjustment, on its table, of 6 inches. This machine will bore and face cylinders up to 40 inches in diameter.

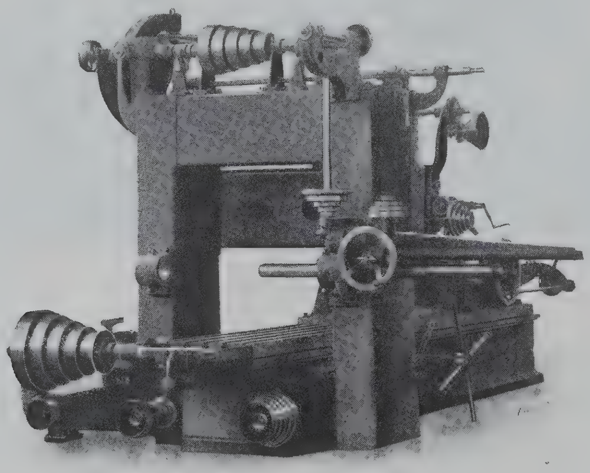


Fig. 2. Cylinder Machine, Back View.

The milling spindle, shown on the cross rail, is driven by a 3-inch belt on a five-section cone, giving speeds from 10 to 102 revolutions per minute. These speeds are suitable for cutters from ¾-inch to 7 inches in diameter running at a cutting speed of 20 feet per minute. The milling feeds run from 7 to 4 inches per minute at all speeds. The spindle has a feed on the cross rail of 40 inches and is adjustable above the table from 10 to 33 inches, 6 inches of which is the spindle head adjustment in the saddle.

The spindle used for boring the crank-shaft bearings is 3 inches in diameter and has a feed of 36 inches. It is driven by a 3-inch belt on the same cone that is used for driving the milling spindle, since the milling spindle and the crank-shaft boring bar are not used at the same time. Suitable clutches are provided for shifting from one mechanism to the other. This bar has boring speeds of 12, 16, 21, 28 or 37 revolutions per minute and is suitable for boring, at 20 feet per minute, from 2 to 6 inches in diameter. The feeds are 13 1-3, 40, 80 and 120 revolutions per inch of travel.

The table is 14 feet long and 24 inches wide, the working surface, from end of table to facing tool, being 8 feet and 3 inches. It is driven by a 3-inch stationary feed screw on which is a revolving nut provided with anti-friction ball bearings at each end. The feed is from 2 to 16 inches per minute, in either direction, regardless of milling spindle speeds. It has an automatic stop and a fast movement of about 15 feet per minute in either direction besides the hand movement. There is a clamping arrangement by which the table is locked when the machine is being used for cross milling or for boring crank-shaft bearings. The traverse of the table is about 9 feet 6 inches and the distance between uprights 40 inches. The boring spindle centers are 15 inches above the top of the table. The weight of this machine is about 25,000 pounds.

BICKFORD DRILL AND TOOL CO.'S TREPANNING MACHINE.

Fig. 2 (next page) shows some drill chips that, by comparison with the three-inch scale, will be seen to be of quite unusual size. These chips were made with a four-inch flat drill operating in solid .45 carbon steel at the rate of 1¼ inches per minute, feed .072 inch per revolution, using water as a lubricant.

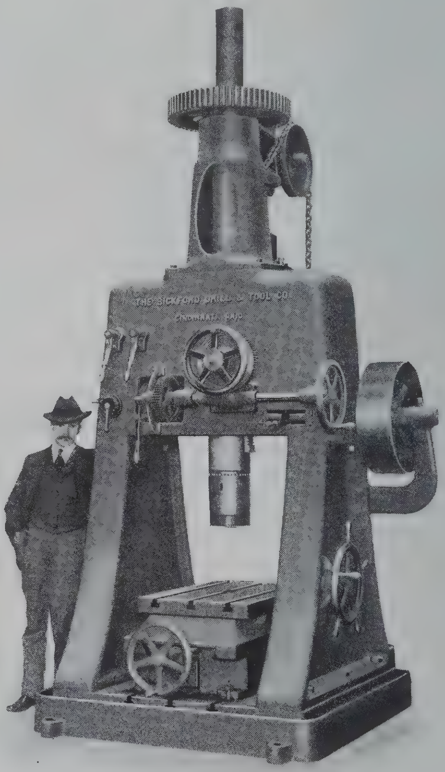


Fig. 1. Three-foot Trepanning Machine.

The machine with which this work was accomplished is illustrated in Fig. 1. It is termed a three-foot trepanning machine and is the product of the Bickford Drill & Tool Co., Cincinnati, Ohio. This is designed for all kinds of heavy drilling, facing, tapping and trepanning and is capable of receiving work 36 inches wide, between the housings. The head and cross rail are made in one piece, so designed as to eliminate all overhanging of the spindle. The table is adjustable both transversely and longitudinally, and when not needed may be slid back out of the way, for which purpose an extension is cast on the base.

The spindle has 16 changes of speed ranging from 6 to 60 revolutions per minute, and eight changes of feed ranging from .01 to .1 inch per revolution. All changes are accomplished by the movement of levers, no belt shifting being required. Both hand and power quick advance and return are also provided.

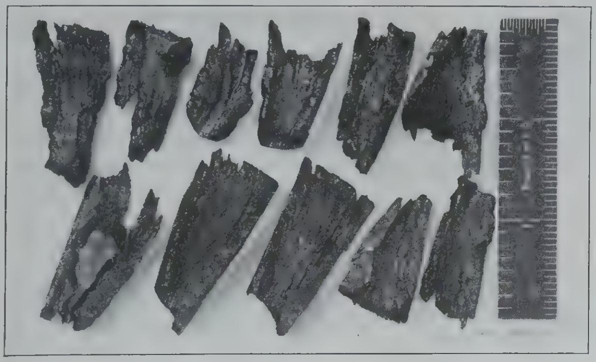


Fig. 2. Chips made with Bickford Trepanning Machine.

ELECTRIC BLUE PRINTING MACHINE.

In Figs. 1 and 2 is shown a new electric blue printing machine that has been placed on the market by the Eugene Dietzgen Co., Chicago. The general arrangement of glass cylinder with its canvas cover is practically the same that has been employed in former machines but for inserting the paper and tracing, the cylinder can be swung down into a horizontal position, making the manipulation much easier than is possible where it remains upright. After prints have been put on one side of the horizontal cylinder it is turned completely over and prints are placed on the opposite side. The cylinder is then tipped up and locked in a vertical position ready for printing. By touching a lever the arc lamp starts in its descent through the center of the cylinder at a speed that can be regulated to suit the sensitiveness of the paper employed. When the lamp has reached the lowest point of the printing surface it automatically reverses its motion and returns to its original position above the cylinder. The operating mechanism is all mounted on the back of the stand so that the machine is entirely self-contained.

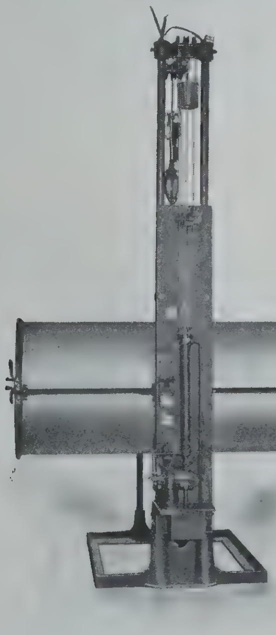


Fig. 1. In Position for Loading.

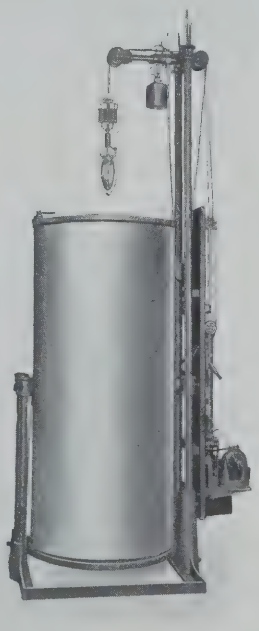
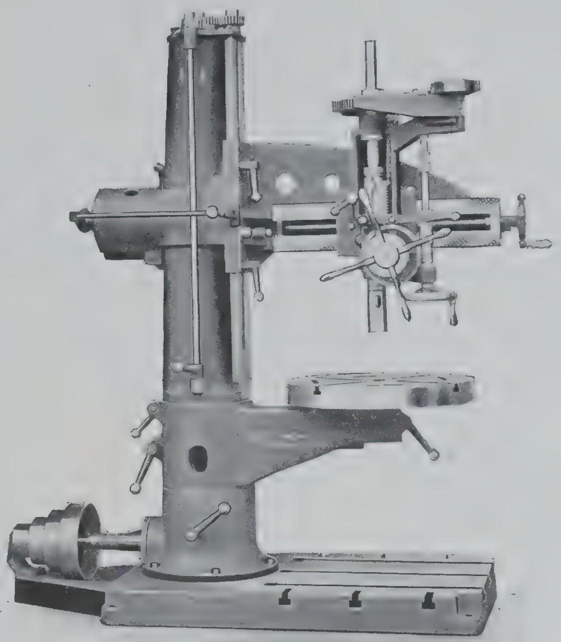


Fig. 2. In Position for Printing.

A NEW DRILL MANUFACTURED BY THE DRESES MACHINE TOOL CO.

The Dreses Machine Tool Co., Cincinnati, O, have just brought out a new radial drill which, after a thorough trial, is now ready for the market. The outline of this drill follows quite closely that of their old machines, only all vital parts have been made stronger and heavier. A lever, which may be seen protruding through the arm near the column, is used for quickly starting, stopping and reversing the spindle for tapping. It also engages the back gears according as its position is central, right or left. The little knurled head screw, passing through this lever, limits the brake power of the forward driving friction clutch and can be so adjusted that it just drives the tap but slips if the hole is too small, or when the tap strikes the bottom of the hole or any other obstruction. In connection with the gearing on the two horizontal driving shafts are four friction clutches which are operated by two levers, while any one of four quick-return levers disengages the feed and operates the spindle. This is accomplished by a single movement with but one hand. There are four changes of feed which can be varied by shifting the knob on the feed rod while the machine is in operation. The spindle is provided with a depth gage and an automatic stop.



Dreses Machine Tool Co.'s Radial Drill.

EXTENSIBLE STOCK DRAWER RACKS.

The "elastic" principle, which has long been employed by the Globe-Wernicke Co., for the construction of book cases in sections or units, has recently been applied by the Cleveland Wire Spring Co. to iron racks with steel boxes for holding tools, shop supplies, etc. One of these racks, consisting of seven sections, with drawers facing on both sides, is shown in the accompanying half-tone. A rack of this capacity is 8 feet high, 8 feet long and 32 inches deep, while the length may be increased indefinitely by the introduction of addi-

Rack of Steel Stock Drawers.

tional sections. The boxes are made of sheet steel with the angles turned on all corners, making a strong and durable box, which is very desirable in case of fire. One concern, recently burned out, lost almost all of their small tools except what they had in these trays, the contents of which were taken out practically uninjured.

These cases are used by a large number of firms who prefer them to wooden boxes on account of their convenience, cleanliness and durability.

THE NEW MODEL TURRET LATHES.

The Pratt & Whitney Co., Hartford, Conn., have recently re-designed two sizes of their new model turret lathes, retaining those features of the early machines which have proved of merit and adding new features for increasing the accuracy, capacity and convenience of the machines. While they are designed for manufacturing in large quantities, yet the tools of these machines may be set so easily that it is often of advantage to employ them for making as few as six pieces. The capacities of the two improved machines are, respectively, ⅝ x 4½ inches and 1 x 10 inches, which latter is shown in Fig. 1. As will be noticed in this cut, the headstock, bed and pan are cast in one piece. This arrangement insures alignment of the head and bed, and connects the parts in the best possible manner. The reversed position of the cones permits the front bearing to be reinforced and better provides against springing when heavy cuts are being taken. The end thrust of the spindle is taken entirely on the main bearing.

A detail of the turret and turret slide is shown in Fig. 2. The slide runs directly on the bed of the lathe, thus avoiding any intermediate construction and making the alignment more permanent. The sliding surfaces are gibbed underneath so that the transverse alignment of the cutting tool is not disturbed in making adjustment for wear. On the ⅝ x 4½ inch lathe the turret slide is moved by a lever, but on the larger size either lever or capstan wheel may be used, the change being quickly made from one to the other. The turret revolves about a heavy conical post which is bored, in alignment with the machine, to permit work being passed through the turret when necessary. The locking bolt, which is of steel, is provided with a taper gib and may be adjusted for wear without removing the turret from the slide. Locking takes place directly under the turret head, and no matter how quickly the turret may be indexed it is impossible for it to "over-run" or be carried beyond the index notch. When but two turret tools are used, the index mechanism may be thrown out by giving a partial revolution to the disengaging pin *P* Fig. 2. This allows the head to be indexed back and forth by hand between the two tools. The regular indexing is put into operation again by simply turning this pin back to its original position. On the base of the turret head is a cam *J* which, by acting upon the roller *K* and through the shaft *L*, causes the lever *M* to swing in or out as the turret revolves. The lever, therefore, occupies a series of positions corresponding to whichever hole of the turret is in working position. For each of these positions there is a stop, *S*1 *to S*6, which is adjusted to give the proper length of feed to its corresponding tool. The lever *M* at all times bears against the bracket *N*, so that when it comes in contact with one of the rods the feed of the turret slide is brought to a positive stop and no undue straining on the capstan wheel can in any way injure the turret mechanism.

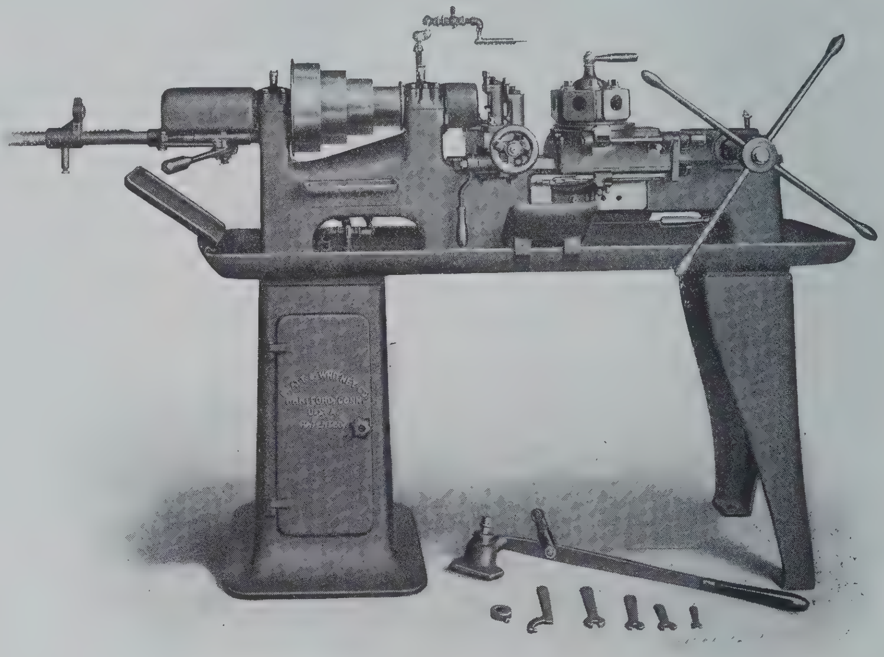


Fig. 1. 1 inch x 10 inch New Model Turret Lathe.

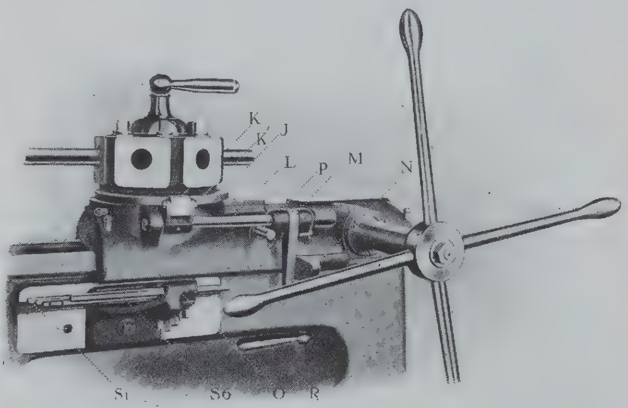


Fig. 2. Turret and Turret Slide.

The rod feed used on these machines is a modified form of the Parkhurst type of wire feed, the modification consisting in the use of a feeding sleeve operated through a link connected at a distance from the fulcrum point about double that at which the closing link is located. This construction permits, without sacrificing power in the closing mechanism, double the feed of rod to a given movement of the lever that can be obtained with the standard form of rod feed.

The collets are so arranged that, in closing, they do not withdraw or further advance the stock, a feature that is especially desirable in doing "second operation" work. For turning short pieces, such as rings or collars, which have a diameter above the capacity of the regular collets, split step chucks are supplied, thus materially increasing the range of work that these machines will handle. In these chucks the feature of the non-withdrawal of the chuck in closing is retained. By reason of the small diameter of nose-piece for a given diameter of collet it is possible to employ a heavy double cross slide directly under the collet and to support the cut-off and forming tools on the same without overhang. This slide may be placed anywhere between the headstock and the turret slides and rigidly clamped at any desired location.

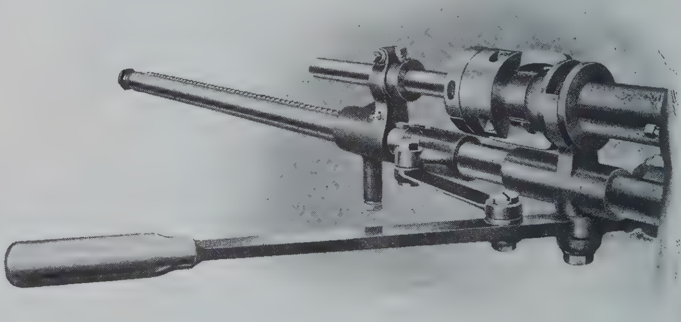


Fig. 3. Rod Feed Mechanism.

There are adjustable stops for the forming and cut-off tools. The tools may be operated by lever feed, if the work is light, or by handwheel and screw mechanism when the work is heavy or the tool not easily controlled by the lever.

The turret tools are made with a wide range of adjustment to cover a great variety of shapes. In Fig. 4 is shown the single roughing tool with steady rest. The cutter holder swings from a center so that the point of the tangent tool varies the least possible from the best cutting position, no matter how large or how small the piece operated upon may be. The cutter is adjusted by the screw at the top and locked by a clamp screw. When it is desired to withdraw the cutter, the clamp screw is loosened and the tool swung back. It is equally easy to return the cutter to its proper position by bringing the adjusting screw to the stop upon which it bears. The single finishing tool with steady rest is snown in Fig. 5. This tool has the same form of steady rest as the roughing tool but the cutter is held radially in a swinging arm.

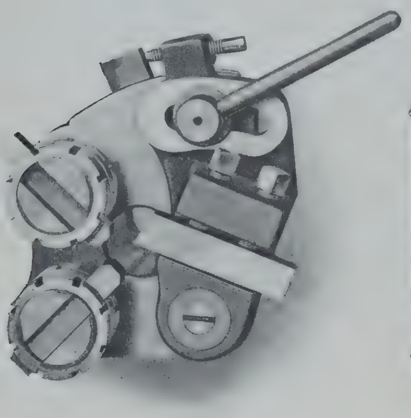


Fig. 4. Single Roughing Tool

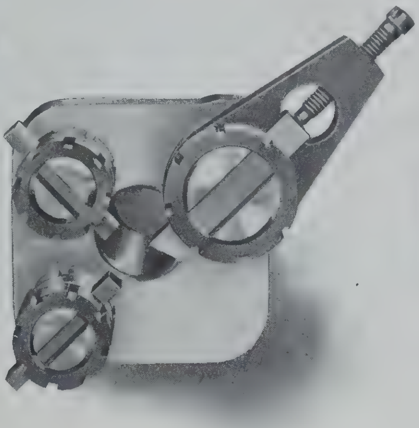


Fig. 5. Single Finishing Tool.

On work having two or three shoulders a multiple tool, one of which is shown in Fig. 6, can be used to good advantage. The tool illustrated is a finishing tool but multiple roughing tools also are made for use with these machines. The steady rests are identical with those on the single tools except that the slotted stud is lengthened to accommodate two or more jaws. Each of the cutters is entirely independent and adjustable while the distance between the shoulders may be almost anything within the total range of the tool. The shank of all of these tools is hollow, in order that work may pass directly through the turret.

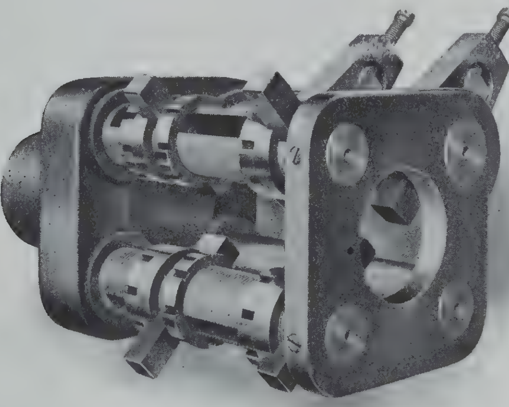
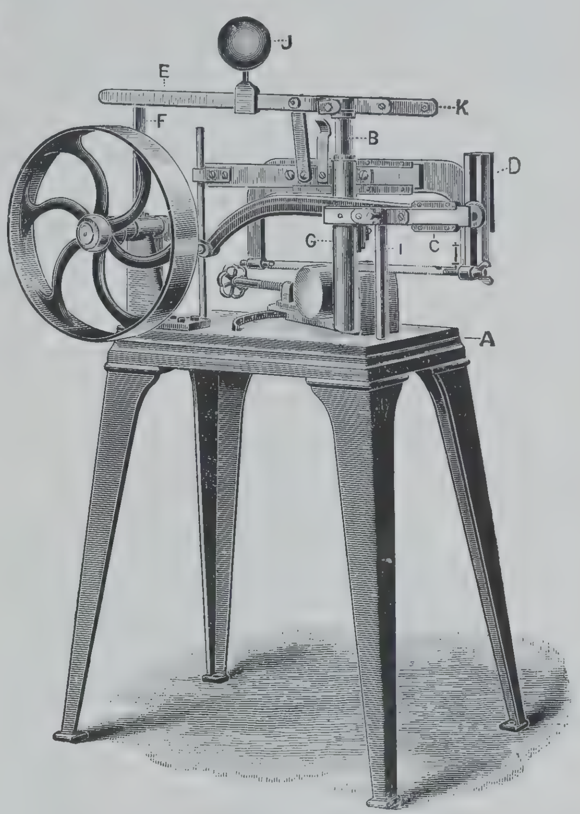


Fig. 6. Multiple Finishing Tool.

IMPROVED POWER HACK SAW MACHINE.

Although it is only a few years ago since the first power hack saw machine was brought out, it is now considered a necessity in every machine shop, and is a tool often found in other shops and in stores where bar iron and steel must be cut into lengths. The first power saws were crude tools that cut off stock, it is true, but in a haphazard and irregular way. No one would trust one of the earlier machines to saw off disks requiring to be finished to exact thickness without allowing a liberal margin for the "run of the saw."

In the power hack saw machine illustrated in the cut, we have a tool that is carefully designed and constructed. It produces quite remarkable work, it being possible to cut off very thin disks from a steel bar, showing little if any deviation from parallelism between the two sides. This result is obtained by certain features of design which constrain the saw blade to feed vertically downward in a perfectly straight line, there being no tendency for the connecting-rod to twist the saw out of true. By referring to the cut it will be seen that the connecting-rod is attached to the slide *C*, which moves on a guide entirely independent of the saw frame. The saw frame is not rigidly attached to the guide but is connected to it by a pin working in a vertical slot shown at *D*. This permits the saw to be moved up and down without changing the angularity of the connecting-rod, or in any way interfering with the regularity of the reciprocating motion. The saw frame is supported by a slide at the top moving on a horizontal guide attached to a sleeve. This sleeve encircles the vertical post *B*, the post acting as one of the vertical guides. A saw guide, adjustable in all directions, is attached to the sleeve so as to straddle the saw blade close to the work. Gages are provided for setting the saw blades truly vertical, but after a blade has once been set it may be quickly replaced by another without any adjustment whatever. This is considered to be an important feature in producing a true vertical cut, and preventing saw blades breaking. The saw frame is lifted and lowered by the lever *E*, and a weight *J* is mounted on the lever to regulate the cut. As the saw becomes dull the weight is moved outward on *E* to increase the leverage. The vise is swiveled so that it may be set for angular cuts. It is shown in the extreme angular position, or 45 degrees. No countershaft is required, there being a clutch with handle *F* attached to the machine for starting and stopping. When the work is sawed through, a bell rings continuously until the machine is stopped.



Power Hack Saw, Cutting Steel Disks.

This power hack saw machine is made in three sizes, 2x2, 3x3, and 4½x4½ inches, by L. H. Olmsted, Hasbrouck Heights, N. J.

AUTOMATIC THREE-WAY BORING AND TAPPING MACHINES.

The machine shown in Fig. 1, p. 228, is used for tapping tees, crosses, elbows, globe, angle and cross valves, or in fact, any kind of work that requires tapping and is within the limits of the capacity of the machine. It is capable of cutting simultaneously, three ½-inch pipe threads in brass.

The machine is spiral geared throughout and is absolutely noiseless. It is driven with a pair of wood and iron friction clutch pulleys with open and crossed belts. The countershaft has cones for three different speeds. The different feeds of the spindle are positive and are accomplished by change gears in a manner similar to that employed on a lathe. The feed gears are arranged with a clutch to which the spindles can be adjusted, independently of each other, for different depths of taps.

The chuck, shown in the photograph, is of the ordinary, two-jaw type with right and left hand screws, so adjusted as to receive special jaws for different kinds of work. In the place of this may be substituted a double chuck that is pivoted in the center and holds two pieces of work, back to back. The instant the taps have returned far enough out to clear the work, this chuck is revolved half way round and the new fitting is presented in front of the taps, and while the machine operates on this piece, the one previously finished is removed from the chuck and a new piece put in; in this way the delay due to taking out the finished piece and putting in a new piece, as is necessary on the single chuck, is avoided.

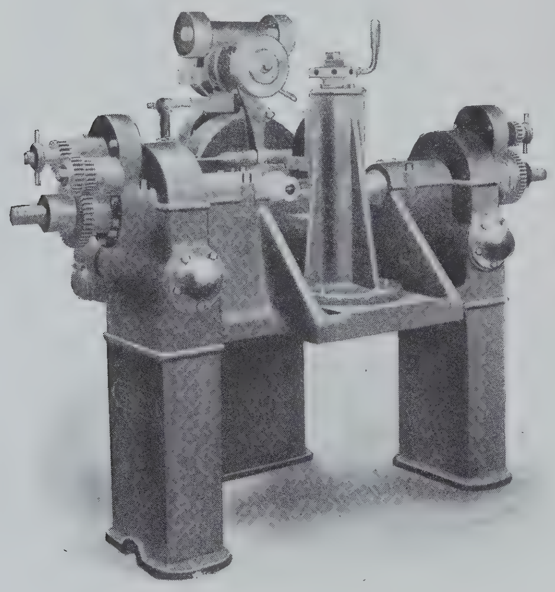


Fig. 1. Automatic Three-way Tapping Machine.

The regulator or governor is that part which is prominent on the housing of the center spindle. It has two small pulleys which are driven from the countershaft by independent belts. One belt would be sufficient for the work required but if this should break there would be no means of reversing or stopping the machine except by stopping the countershaft, so the second belt is added for safety. The regulator is of the most positive action without any storage of power in springs. When the taps have cut deep enough into the work the regulator reverses the large friction clutch pulleys, unscrews the taps out of the work and stops the machine. The operator then revolves the chuck half way around, thereby bringing a new casting into position for machining, starts the machine and the operation is repeated. The operator can at any and all times control the machine by the crank handle on front of regulator, that is, he can stop it or reverse it or run the spindles all the way back, without interfering with the automatic adjustment of the tap. When the taps are going into the work the machine will reverse automatically at the proper distance in, and on coming the proper distance out it will stop.

The machine is provided with an arrangement whereby the taps, when they unscrew from the work, will start one after the other, the benefit of this being that they will not injure the thread in the work when coming back, and will start reversing very much easier than if the three spindles should all start backwards at the same time.

For tapping iron or steel the machine is furnished with an oil pump, and a wrought iron pan for catching the chips and oil.

A companion to this is the three-way boring machine shown in Fig. 2, which is similar in construction and operation to the tapping machine but bores and faces only. It is used on valves and fittings which require boring and facing previous to being tapped.

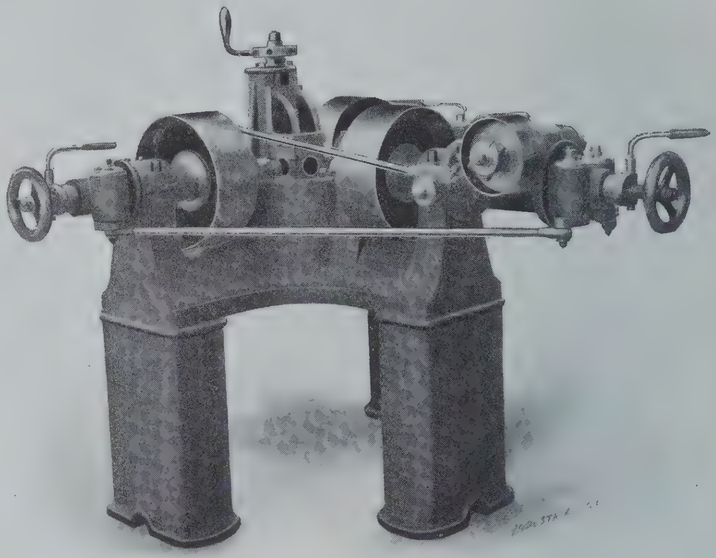


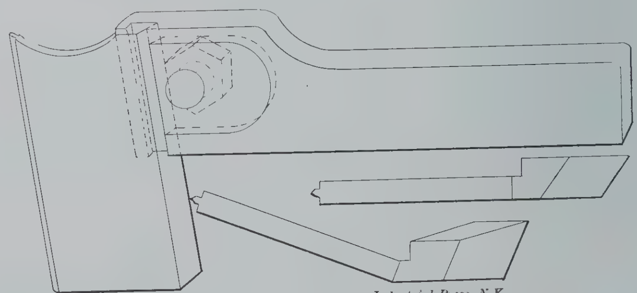
Fig. 2. Automatic Three-way Boring Machine.

The chuck, either single or double, is identical with that used on the tapping machine and the same special jaws will fit both machines. The cutting tool is a multiple combination of counterbore and facing tool and the feeding mechanism is so arranged that when the tool first enters the work the feed is quite coarse. As the tool goes deeper into the work the feed decreases until, when the flanges or ends of the work are being faced, one or two revolutions are made without any feed at all. This produces a smooth hole and a nicely finished surface. The tools have a quick return movement and three different feeds which may be instantly changed from one to the other. As soon as the tool has been withdrawn from the work the feed comes to a standstill while the spindle continues running, but the feed will not start until the operator is ready, when it is started by lifting a small handle on the front of the machine. Each spindle is provided with independent adjustments for depths.

Both of these machines are manufactured by Edward P. Walter, Bridgeport, Conn.

THE O. K. CUTTING-OFF TOOL.

A new and convenient cutting-off tool that has recently been patented and placed on the market by the O. K. Tool Holder Co., Shelton, Conn., is illustrated in the accompanying cut. The peculiarity of this tool, as will be seen, is the formation of a point in the center of the cutting edge. This breaks up the chip and causes the tool to make a clean cut. In order to grind the blades they may be removed from the holder without changing its position, while the shape of the blades is such that grinding does not disturb the accuracy of the cutting edge. The tool can be adjusted to take a chip of any thickness and will not dig in, break or spoil the work. Straight or off-set blades may be used in the holder as is desired.

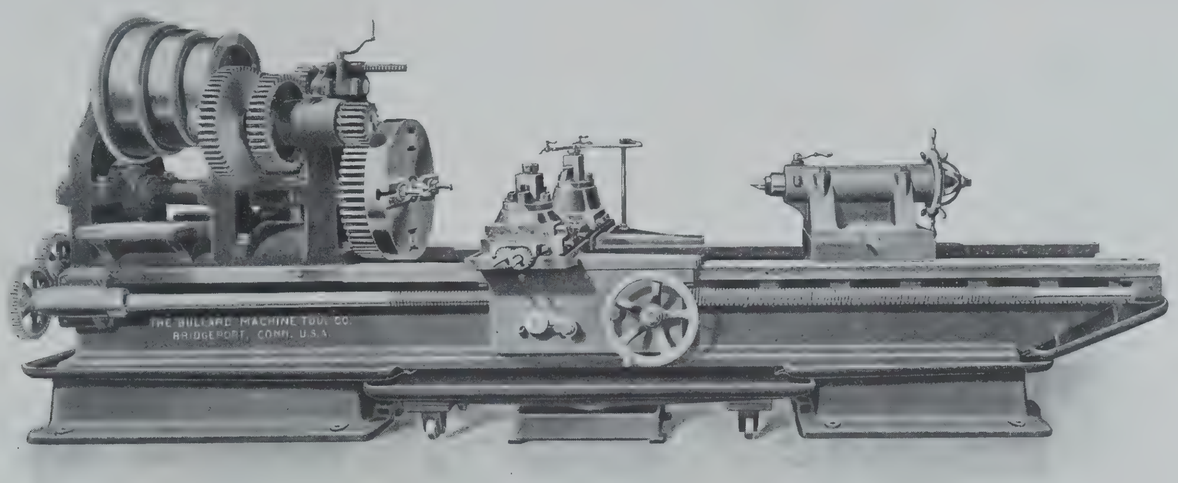


Industrial Press, N.Y.

O. K. Cutting-off Tool.

TWENTY-SIX INCH RAPID REDUCTION LATHE.

With the advent of the present high grades of tool steel, allowing cutting speeds of 100 to 200 feet per minute, a demand has arisen for tools that are qualified to withstand the increased service which the use of such speeds involves. It is to meet this demand that the Bullard Machine Tool Co., Bridgeport, Conn., have produced the "rapid reduction lathe" which is here illustrated. The simultaneous demand for great power and high speed makes the use of large gear reductions out of the question so that efficient driving power must be depended upon for accomplishing the work. Realizing the importance of this, the builders have designed this tool to be driven by a six-inch double belt, or, when electrically operated, by a 20 horse power variable speed motor. The lathe throughout possesses weight and solidity far in excess of that usually met with in machine tool construction. It swings 26 inches over the ways and 15 inches over the carriage. The bed, which is exceptionally heavy, weighs about 375 pounds per running foot and is regularly made in 14- and 16-foot lengths, taking 6 and 8 feet between the centers, but special beds can be furnished of any length desired.



Twenty-six Inch Rapid Reduction Lathe.

The tops of the column legs are completely surrounded by drip pans while between the legs are large pans that are mounted on rollers to facilitate their use. This arrangement of pans permits the copious use of water, which is supplied by a rotary pump capable of delivering five gallons per minute. The ways are flat and thus give an ample bearing surface for the carriage, while wipers on the ends of the carriage prevent chips from lodging and cutting the ways.

The headstock has a three step cone, the steps of which are respectively 18, 21 and 24 inches in diameter, and is faceplate geared in the ratio of 8 to 1 and 16 to 1. These gears are all completely inclosed by casings which are not shown in the photograph, having been removed in order to show clearly the details of the headstock. An equalizing driver is incorporated into the faceplate, thus permitting the use of double tailed dogs. All of the headstock journals have chain oiling bearings and liberal reservoirs are provided for the oil supply.

The carriage is gibbed, both front and back, and has a full length bearing of 38 inches on the ways. The cross slides, of which there are two, are square locked throughout, adjustment for wear being obtained through taper gibs. The front slide has a compound movement for dividing the cut between the front and rear tools. These tools are made from 1½ x 2½-inch stock. The slides are independent in their movements and have no power cross feed. The feed is driven by gearing and a powerful leadscrew which is located close to the bed and well under the forward way. This screw is engaged by a long lock nut operated from the apron, the Acme standard thread with which this screw is cut making engagement and disengagement very easy. Feed reverse is obtained by use of an intermediate gear on the headstock. On the long beds the leadscrew is carried in supports that are automatically placed, at given intervals, by the carriage as it travels along the bed. A quick-acting power traverse is provided for moving the carriage rapidly, also a rack and gear for moving both carriage and tailstock by hand. The tailstock has a 5-inch steel spindle and set-over movement. Center and follower rests partake of the same rigid and substantial features that are characteristic of the other parts of the lathe.

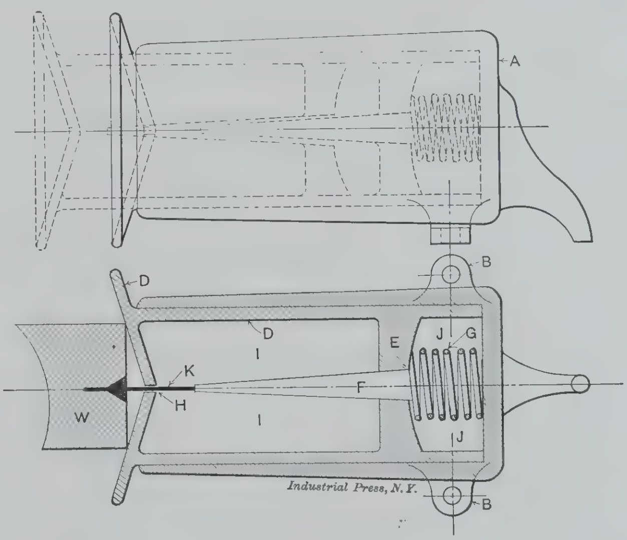
When it is desired to operate this tool electrically, a 20 horse power variable speed motor, capable of running 600 to 1,000 revolutions per minute, is mounted on brackets cast on the headstock, the armature shaft of the motor replacing the cone shaft of the belt-driven machine. This motor is operated from the lathe apron.

DEVICE FOR CLEANING AND LUBRICATING CENTERS.

A. B. Christman, of Cleveland, Ohio, has brought out the appliance shown in the accompanying cut, which is for the purpose of removing oil, chips, or dust from the countersunk holes in the ends of work held between centers. It may be attached to the legs or column of centering, milling or grinding machines or to lathes or benches.

The cylinder *A* is fastened by screws through the lugs *B B*, so that it will stand in a vertical position.

Inside of this cylinder is a sliding piston *D*, provided near its lower extremity with the piston head *E* and having an inverted cone at the top. Fixed to *E* and central with the small hole *H*, in the cone, is the nozzle *F*. A spring *G* keeps the piston well up in the cylinder, as shown by the dotted lines. The spaces *I I* and *J J* contain benzine, kerosene, or soda water. If it is desired to lubricate the center simultaneously with the cleaning, lard or machine oil is mixed with the cleaning fluid. The work is grasped in the hand and inserted in the cone as shown at *W*, with a slight downward pressure. This pushes the plunger *D* downward and a stream of the



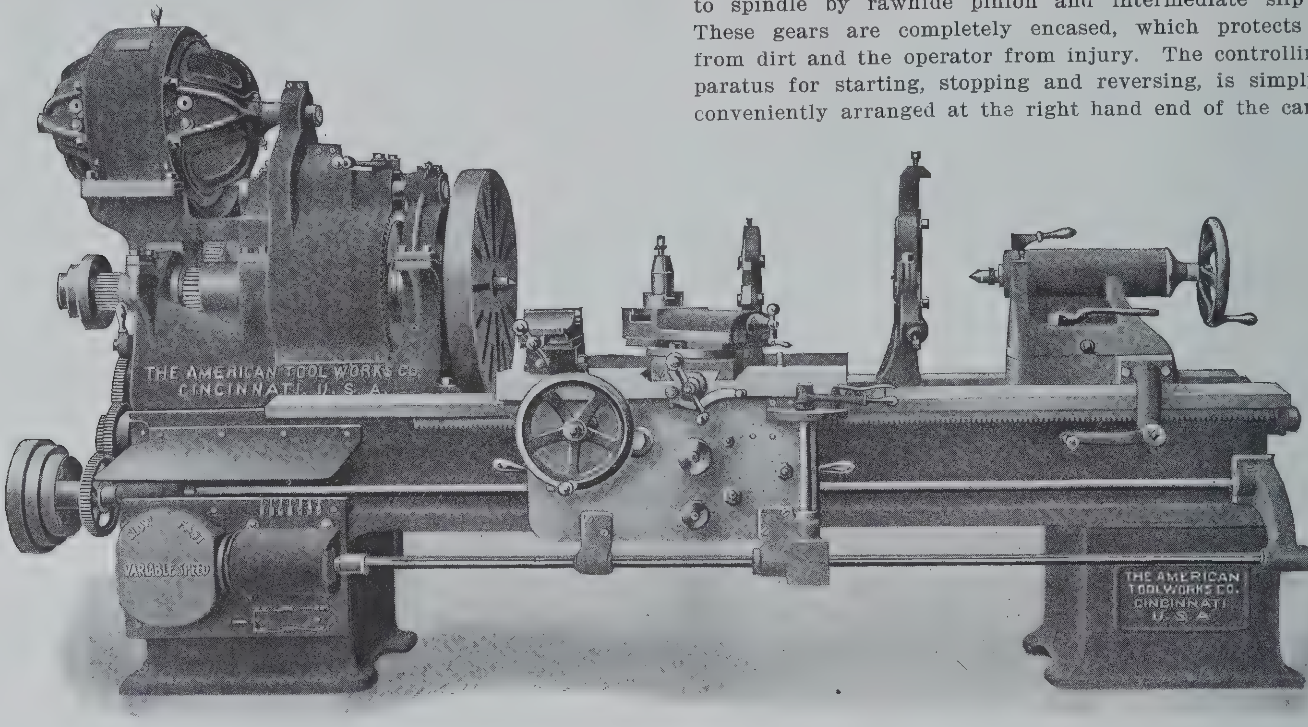
Center Cleaning Device.

liquid is forced upward into the center as shown at K. The liquid returns by gravity through the hole H into the chambers I and J, carrying with it all particles of dirt and chips, which are retained by the partition E. Cleaning of the device is necessary only at comparatively long intervals and is accomplished by lifting the piston D out of the cylinder and dumping. The capacity of the cleaner is about six ounces of cleaning fluid.

NEW "AMERICAN" MOTOR DRIVEN LATHE.

The application of electric drive has been adopted by the American Tool Works Co., Cincinnati, Ohio, for operating their 24-inch engine lathe, a photograph of which is here reproduced. This is their standard lathe having the leadscrew on the inside of the bed.

The motor is of the double commutator type, 3 H. P., and is mounted on a saddle on the head, with communication direct to spindle by rawhide pinion and intermediate slip gear. These gears are completely encased, which protects them from dirt and the operator from injury. The controlling apparatus for starting, stopping and reversing, is simply and conveniently arranged at the right hand end of the carriage.



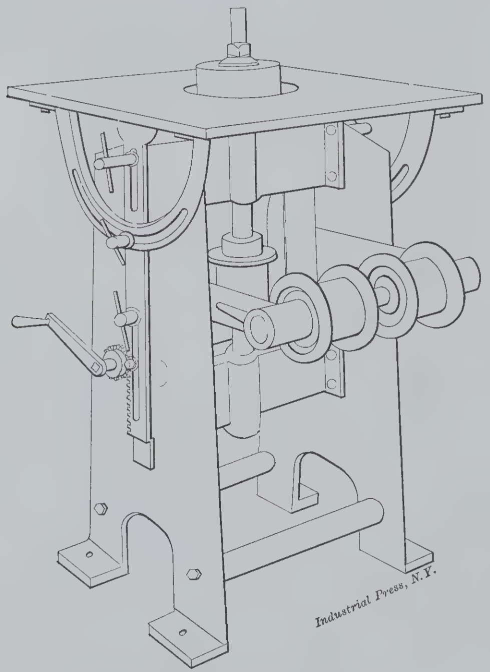
24-inch "American" Motor Driven Lathe.

There are four fundamental speeds obtainable from the motor itself through the speed controller directly under the head. This with the spindle gearing, gives a total of sixteen distinct and positive spindle speeds available. The efficiency of the motor is practically constant at all speeds. The motor, when reversed, runs at the same speed as when going forward.

* * *

VERTICAL EDGING AND INSIDE GRINDER.

The Tucker Machine Co., Cincinnati, Ohio, have recently brought out the vertical grinder shown in the engraving. This machine was originally built for use in stove foundries but has proved of value for grinding many kinds of castings such as plate castings, architectural iron work, etc. It is of the greatest convenience for grinding the inside of scrolls, circles or other parts that cannot be reached by the ordinary horizontal grinder. The work to be ground rests upon a horizontal table, two feet square, that can be tilted to any desired angle and may be raised and lowered, by means of a crank handle, through a space of four inches. The machine carries a wheel 2 inches to 8 inches in diameter by 4 inch face.



Vertical Edging and Inside Grinder.

LEAD VS. NICKEL (OR EDISON) BATTERIES FOR AUTOMOBILES.

Those interested in automobiles are waiting patiently for further information about the Edison storage battery, of which so much is expected. While, from the testimony of Mr. Edison, this battery has undoubted advantages, the most important of which are large capacity for a given weight and increased durability, it would appear from a paper read recently by Mr. Hugh Rodman before the Electro-chemical Society at Niagara Falls and reported in the *Electrical World and Engineer*, that the lead battery may still lay claims to favorable recognition. After discussing the numerous possible storage battery combinations and the corresponding reactions the conclusion is reached that the list of available anodes and electrolytes finally reduces to lead in sulphuric acid and nickel in an alkali hydroxide. Practically there are only two classes. First, lead peroxide and spongy lead upon lead plates in sulphuric acid—the battery in general use; and, second, mercuric or nickel peroxide upon nickel plates, together with cadmium, nickel or iron sponge upon iron or nickel plates in an alkali hydroxide—the battery proposed by Mr. Edison.

The alkali battery possesses a great advantage in making its support plates of a stiff, easily-worked metal. The stiffness insures absence of buckling (a trouble which must be considered and compensated for with lead plates), while the stiffness and ease of working together admit of a high mechanical perfection. It should be borne in mind, however, that the ordinary antimonial lead grid used with pasted lead plates is neither prohibitively heavy nor short-lived; it will probably last as long as the nickel grid when subjected to electrolytic action only; the inferiority lies in its mechanical weakness and in the difficulty of making fine castings.

In refilling the alkali cell pure or distilled water must be used, which is not necessary with the acid cell, and the alkali is also more troublesome in handling owing to its tendency to spread and its more destructive effect on clothes, hands and woodwork. The voltage of the alkali cell is only about one-half that of the lead cell, and for the same energy output we must double either the current or the number of cells. The alkali cell also has comparatively a small mass of electrolyte to draw upon.

Data are wanting upon the capacity of the alkali cell per unit of volume and weight, but it seems reasonably certain that neither will be far different from that of the pasted lead battery. As for reliability, which must not be mistaken for long life, data on the alkali cell are again wanting and must be wanting until the cells are put into ordinary service with ordinary care and attention.

For light service, such as for electric wagons, where watt efficiency and cost are to some extent subordinate to convenience, the choice between these two types will depend largely upon capacity and reliability.

The commercial life of lead plates in truck or cab service is about 15,000 to 20,000 miles for negatives, 12,000 miles for Plante positives and 6,000 miles for pasted positives. In other words, a four or five ton truck running 20 miles per day for 300 days in a year requires new positives once in a year or once in two years, according to the type of plate used, the choice of one or the other being determined by the character of service and length of run desired. Cabs and lighter wagons have about the same life, with a capacity of 40 to 100 miles on one charge.

* * *

In the June, 1902, issue of MACHINERY a description was given of the Keller pneumatic riveting hammer made by the Philadelphia Pneumatic Tool Co. Some readers who have studied the sectional cut, or who are familiar with the hammers themselves, may have wondered how the long 3-16-inch holes are drilled in the barrel parallel with the cylinder bore. In some of the long-stroke riveting hammers these holes are fully 13 inches long, so it would seem like a quite difficult job to drill them with ordinary appliances, but that is how they are done, except that the appliances are somewhat better than ordinary ones.

Seven Brown & Sharpe sensitive drilling machines built specially for this work are used in drilling the long holes in each barrel, the work being done progressively. The hammer barrels are mounted on jigs having a round, flat base, and each one remains in its jig until the holes are drilled clear through. The first operator starts the holes with a short 3-16-inch drill, and drills them to a depth of perhaps 2 inches. The next operator takes it on his machine and deepens the holes, say, 2 inches, and so on, the skill of the operators increasing with the depth of the holes and their ability to avoid breaking drills and spoiling work. The last operator in the line is a deaf mute and not likely to be distracted, which may partially account for his position in the line. The holes being drilled in this manner the long drills are always supported throughout most of their length by the walls of the hole, which insures the holes being straight, and because of the frequent changes there is not so much danger of their heating.

* * *

FRESH FROM THE PRESS.

A GRAPHIC METHOD FOR SOLVING CERTAIN QUESTIONS IN ARITHMETIC AND ALGEBRA. By George L. Vose. No. 16 Van Nostrand Science Series bound in paper boards. Published by D. Van Nostrand Co., New York. Price 50 cents.

As the title indicates, this little book describes a graphic method that may be employed for solving certain problems in arithmetic and algebra. The graphic method is one that usually appeals to the practical man, and in this work he will find some quite knotty problems worked out with surprising ease by the use of simple diagrams.

PROBLEMS IN MECHANICS FOR ENGINEERING STUDENTS. By Frank B. Sanborn, Professor of Civil Engineering, Tufts College. Published by the Engineering News Pub. Co., 220 Broadway, New York. 155 pages illustrated. Price $1.50.

This little handbook should prove of great value to students. It is a collection of a large number of practical problems in mechanics, with their answers. It is thoroughly indexed, and as a class-room book and an aid to the instruction of students it will be found useful. The best way to learn mechanics is by working out problems, and one who has faithfully gone through this little volume cannot fail to gain a good knowledge of the subject.

MACHINE SHOP ARITHMETIC. By Fred H. Colvin and Walter L. Cheney. 131 pages and 8 diagrams, nicely bound in cloth. Published by the Derry-Collard Co., 256 Broadway, New York. Price 50 cents.

This is the third edition, eighth thousand, of a little book that has proven popular with machinists and others who have felt the need of a "pocket book containing some of the problems of everyday shop happenings, and affording their fast and accurate solution by easy methods." It is a book we have often recommended to young machinists who have not had the advantages of a good common school education, and who, realizing their deficiency in calculating simple shop problems, have been anxious to acquire a ready knowledge of machine shop arithmetic. The matter contained in the new edition has been revised and brought up to date. Larger type has been used and a larger page which materially improves its appearance and legibility. A chapter on the metric system and metric conversion tables has been added, also a page index.

WORM AND SPIRAL GEARING. By Frederick A. Halsey. No. 116 Van Nostrand Science Series. Published by D. Van Nostrand Co., New York. 85 16 mo. pages with numerous diagrams. Price, boards, 50 cents.

This book is a reprint of Mr. Halsey's articles on the above subjects that originally appeared in the columns of the *American Machinist.* The first part, dealing with the worm gear, considers the theory of worm efficiency, limiting speeds and pressures, and the various types of thrust bearings for use with the worm. The theoretical treatment is supplemented by a number of cases from actual experience showing the efficiency that can be obtained and the factors tending to produce this efficiency. The second part, after a few pages explaining the general principles of spiral gearing, illustrates the subject by the solution of a practical problem which is solved both by the analytic and the graphic methods. The concluding pages are devoted to a short treatise on the selection of spiral gear cutters by Mr. J. N. LeConte.

THE SLIDE VALVE. By Julius Begtrup, M. E. Published by D. Van Nostrand Co., New York. 143 8-vo. pages. Illustrated. Price, cloth, $2.00.

In this book Mr. Begtrup explains the principles of the various types of slide valves and also analyzes and describes a number of special valve constructions in order to exhibit in a comprehensive manner how the exacting conditions of high steam pressure and high speed have been met by modern engine builders. The information is presented in a more or less explanatory form supplemented by graphical demonstrations of the valve movements. The valve diagrams used in this book have been in use for the past ten years with, it is claimed, more general satisfaction than others that are better known. Beginning with a chapter on the common slide valve, the chapters successively deal with the improved forms of slide valve, including double-ported, balancing and piston valves; four valve systems, of which the Corliss is the most familiar type and independent cut-off valves. A chapter is also devoted to the slide valves of pumps, the valves of all the well-known makes of pumps being considered. The last chapter deals with the angularity of the connecting rod and eccentric rods and the effects which this produces on the steam distribution.

MATERIALS OF MACHINES. By Albert W. Smith, professor of Mechanical Engineering in Leland Stanford Junior University. Published by John Wiley & Sons, New York. 133 pages. Illustrated. Price, cloth, $1.00.

In the words of the author, this book is the result of an effort to bring together concisely the information necessary to him who has to select materials for machine parts. It is a systematic treatment of the materials with which the machine designer has to deal. It is therefore natural that a greater part of the work should be devoted to the subjects of iron and steel. The metallurgy of these materials is first taken up and this is followed by a description of the different steel processes and a few pages on foundry practice. A chapter is also devoted to the subject of testing, illustrated by stress-strain diagrams. The common alloys, principally the bronzes. are considered and the final chapter takes up the different parts of the steam engine and machine tools and discusses the material best suited for the construction of each part.

A MANUAL OF DRAWING. By C. E. Coolidge, assistant professor of machine design, Sibley College, Cornell University. Published by John Wiley & Sons, New York. 92 8-vo. pages and 10 full-page plates. Price, paper, $1.00.

This manual was prepared for the use of the technical student with the object of presenting a standard drawing room system, the one embodied in this book being an average of the drawing room systems in use in the United States at the present day. It is the intention of the author that the system here outlined shall be supplemented by notes of the student's own acquirement, and for this purpose each page of reading is bound alternately with a blank page. The first part of the manual contains a treatment of the general subjects of drawing instruments, their care and use, drawing materials and blueprint reproduction. The second part is devoted to commercial mechanical drawings, closing with a few pages on the subject of Patent Office drawings. The text is quite thoroughly illustrated by 10 full-page plates of the various conventional forms, mechanical drawings and a Patent Office drawing.

MODERN ENGINEERING PRACTICE, published by the American School of Correspondence, Chicago, Ill. With an introduction by Frank W. Gunsaulus, President Armour Institute of Technology. 10 volumes, of about 350 pages each. Illustrated. Price for the set, $40.

The instruction pamphlets of the American School of Correspondence have been written by a selected list of writers, and these papers on mechanical engineering have been gathered together and published in this set of books. In reviewing the books it should be remembered that they are designed first of all, for home instruction and are intended for the man with limited education who wishes to advance in his chosen line of work. They are, therefore, elementary in their treatment and written as simply and clearly as possible. They are not to be considered as reference books for experienced draftsmen or engineers. Were a man, however, to make himself familiar with the contents of the volumes, he would have a good general knowledge of mechanical engineering and would have laid a substantial groundwork for future study. The mathematics of this course would carry him far enough so that after completing them, he should be able to read intelligently some of the more advanced text books by other publishers. The books are substantially bound, with leather backs, and the printing is clear. Part of the illustrations are from drawings made for this work and part are reproductions of cuts made for manufacturers' catalogues or for other purposes.

VOLS. I. AND II., MATHEMATICS, MECHANICS AND HEATING.—The first volume is taken up with a treatment of arithmetic, mensuration and elementary algebra. The second volume is a treatment of plane geometry, followed by chapters on elementary or applied mechanics and a brief treatment of the subject of heat. The chapters on mathematics cover about the same ground as the usual high-school text books except that the treatment is more condensed; and some subjects are omitted that are frequently taken up in high schools, especially in the treatise on arithmetic, which devotes more space to the fundamental rules and less to other branches of the subject, such as commercial arithmetic, etc. The algebra and trigonometry appear to be the most complete. The subjects of mechanics and heat are covered more fully than in the ordinary text book on physics, though not so completely as, for example, in Jamieson's, Dana's or Wood's elementary mechanics, with which some of our readers may be familiar.

VOLS. III. AND IV., FOUNDRY, FORGE AND MACHINE SHOP PRACTICE.—This volume contains about 300 pages in which space the three subjects mentioned above are treated and, as a matter of course, are not covered with anything like completeness since elaborate text books could be written on almost any one branch of shop work. The attempt is made rather to present the general principles of common shop operations such as would be taught in a manual training school and which would help the apprentice in making a start.

Vol. IV., Machine Design and Boilers.—The chapters on machine design in this book follow very closely the lines laid down by such writers as Unwin, Low and other authors of standard works on this subject. Sketches are given of keys, cutters, bolts, bearings, clutches, flanges and other common machine parts and either formulas or tables are given for proportioning them. The author did not attempt to leave beaten paths or to collect material about recent advances in machine proportions. The sketches are for the most part similar to those in the older standard text books. By far the best part of the work is the treatment of boilers which contains rules or proportions for steam space, heating surface, tubes, grate area, etc., that apparently are well selected, together with a description of various types of boilers and boiler exhausters, including the steam calorimeter.

Vol. V., Chemistry, Metallurgy, Engines.—The chemical subjects are evidently calculated to give the mechanical man a general idea of the composition of ordinary materials that enter into machine construction. They are not intended to touch the subject of chemistry as a separate study. The treatise on the steam engine covers about the same ground as the usual handbooks on the steam engine for stationary engineers, but the subject is treated in a much better manner. There are first descriptions of different types of engines, including pumping engines and condensers and sketches with descriptions of the detailed parts of steam engines. This is followed by a description of governors and flywheels with simple calculations of pendulum and flywheel weights. Following this is a very good treatment of the steam engine indicator, much better than the usual treatise, largely because it is directly to the point and a lot of useless matter is omitted. After this is an explanation of the Zeuner valve diagram, with descriptions of several types of valve gear. The book closes with matter upon the action of steam, in which are calculations involving the use of steam tables, the capacities of condensers, the work done in an engine cylinder, etc.

Vol. VI., Marine Engine and Locomotive Work.—This is really a volume II. on the steam engine, taking up marine engines and locomotives. The subjects are treated in the same manner as the general principles of the steam engine are discussed in the last part of the previous volume. There is a chapter on marine boilers, one on railway cars and one on the air brake.

Vols. VII. and VIII. Electricity and Electrical Engineering. Vol. VII. forms a text book on elementary electricity and magnetism. following which generators, motors and electrical measurements are considered. Numerous calculations are introduced throughout this volume, none of them, however, of an advanced character, and they should be handled easily by one who has taken the earlier mathematics of the course. In volume VIII. are descriptions of various types of dynamo-electric machinery, an explanation of the alternating current transformers, with information upon electric railways and power transmission. These two volumes will be appreciated by men who are familiar with mechanics, and would like to have an advanced treatment of the elements of electricity, as practically applied in modern science.

Vol. IX., Heating, Ventilation and Plumbing.—Relatively speaking, these books seem to be more complete than the others mentioned, because the subjects themselves cover less ground and can be more fully treated within the scope of a single volume. This volume compares very favorably with other treatises upon the subjects, with which we are familiar. It will apparently meet the requirements of a mechanical man in a very satisfactory manner.

Vol. X., Mechanical Drawing.—This, it appears to us, is on the whole the most satisfactory volume of the series, and we believe it will prove as satisfactory to instructors and students as any text book on drawing we have seen. It takes up the usual geometrical work, projection, etc., and this is followed by a rarely good section on working drawings, quite original in its treatment and from which we publish an abstract in another part of the paper.

ADVERTISING LITERATURE.

The Billings & Spencer Co., Hartford, Conn. New circular and price list of drop-forged lathe dogs manufactured by this company.

E. G. Smith, Columbia, Pa. Pamphlet descriptive and illustrative of the "Columbia" calipers, spherometers, and screw micrometers. Also of the "Which Way" pocket level.

The Ransom Mfg. Co., Oshkosh, Wis. Catalogue "F" of grinding and polishing machinery. The various sizes and styles of these machines are described and illustrated.

The Frank Mossberg Co., Attleboro, Mass. Pocket catalogue of wrenches and of bicycle and automobile bells. The wrenches are made in several sizes and for various purposes, and the Mossberg bells are fully described and illustrated.

The Billings & Spencer Co., Hartford, Conn. Catalogue and price list of standard automobile forgings. These include forgings of every description in iron, steel, copper and bronze. A number of detail illustrations of various automobile parts are also given.

The Joseph Dixon Crucible Co., Jersey City, N. J. Leaflets giving information about the Dixon graphite pipe-joint compound for insuring a tight joint, but one that can be taken apart easily when necessary.

The Cleveland Wire Spring Co., Cleveland, O. Catalogue of agricultural implement springs and steel receptacles such as mortar and brick hods, hand barrows, nail boxes, various styles of shop boxes, etc.

The C. B. Manchester Gas Furnace Co., Providence, R. I. Circulars of gas furnaces. Twelve styles of furnaces are illustrated. These are for heating cutters, dies, reamers, etc.; for annealing work of steel, iron, brass and other metals; for wire annealing; for melting, plating, tempering, etc., and each is made in several sizes.

Hill, Clarke & Co., Boston, Chicago and New York. Circular descriptive of the Chicago speed lathe, built in 10-inch and 12-inch sizes by the Chicago Machine Tool Co. Also circular calling attention to the line of air compressors, pneumatic tools, pneumatic hoists and appliances manufactured by the Hill, Clarke Co.

The Diamond Machine Co., Providence, R. I. Proof sheets of the revised edition of their 1901 catalogue, indicating the changes in dimensions and measurements of a number of their machines, and in several list prices. Descriptions of their "E" standard grinding machine and of their Nos. 1, 2 and 3 improved water tool grinders will also appear in the new edition.

The Buffalo Forge Co., Buffalo, N. Y. Folders treating of the company's new mechanically-induced draft fans and of Buffalo automatic engines. These engines include the center-crank horizontal, the side-crank horizontal, and the single upright types, simple and compound; also single upright marine engines and the double upright engines of the single and double-acting types.

The Derry-Collard Co, 256 Broadway, New York. Catalogue of books sold by the Derry-Collard method. This is one of the handsomest and most tastefully gotten up book catalogues we have seen. It lists 148 choice technical books, giving each a short and comprehensive description of the contents, number of pages, size of page, and character of binding. An index to the contents is given, which makes reference to any book description easy.

United States Gutta Percha Paint Co., Providence, R. I. Standard catalogue of Rice's 20th century finishes for machinery. These include adamant cement, machine paint, iron filler, enamels, shellac varnishes, etc. They also manufacture a paint thinner for thinning their steel-color paints which dries quickly and costs very little more than turpentine. Three pages in the back of the catalogue contain testimonials from a large number of firms using these products and showing the great variety of work for which they are fitted.

William Jessop & Sons, Ltd., Sheffield, England. Handsomely illustrated catalogue entitled "Jessop's Steel and How They Make it." The subjects of Sheffield steel, "blister steel," crucibles, melting furnaces, shear steel, Siemens steel, etc., are touched upon, and a large number of fine half-tones illustrate the various departments of the company's large works at Sheffield. The manufacture of a crankshaft from the ingot to the finished shaft is also illustrated. In the first pages appears an announcement of the establishment of an American works at Washington, Pa., where Sheffield steel is to be manufactured.

The Northern Electrical Mfg. Co., Madison, Wis. Catalogue No. 26 of the Northern electric motors. Illustrations are given showing these motors driving drill presses, radial drills, grinders, lathes, planers, milling machines, etc., and many other varieties of machines such as sewing machines, paper cutters, ice machines, and air compressors. Vertical motors are shown, of the open and inclosed or dust-proof type for use in cases where other styles of electric motors are not practicable. Much interesting reading on the subject of electric driving is contained in this catalogue and it should prove valuable to those interested in this subject.

The Christensen Engineering Co., Milwaukee, Wis. Catalogues Nos. 53, 54 and 55, standard size, of the air brakes and electrical machinery manufactured by this company. Catalogue No. 53 describes the various parts that comprise the straight air brake equipment for electric cars or trains. No. 54 treats of Christensen air brakes and illustrates the company's new plant, with fine views of its various departments. No. 55 illustrates the direct-current motors and generators, alternating current generators and transformers they manufacture, and contains description of this electrical machinery and of its parts, together with other data and tables and detail drawings relative to the subject. All three catalogues are handsomely gotten up and will prove of value to those interested in the subjects there treated.

The Acme Machinery Co., Cleveland, O. 1902 catalogue of bolt and nut machinery. This catalogue is standard size, very complete and profusely illustrated. It calls attention to the many new features that have been added to their machines since the issue of their last catalogue. The new Acme die head is described and cuts are shown to illustrate its various parts. Then follow engravings and data of the regular Acme die head; Acme bolt cutters for work from ½ inch to 6 inches; 1½-inch single staybolt cutters; a large variety of double and triple bolt cutters, of two, four, and six-spindle nut tappers, etc. A full description, with illustrations, is given of heading, upsetting and forging machines for work from ¼ to 4 inches diameter, and a number of useful tables are reproduced together with much valuable information as to how to make, recut and grind dies, etc.

MANUFACTURERS' NOTES.

Mr. C. H. Schokmiller, for eight years master mechanic and foreman at the Inland Type Foundry Co., St. Louis, Mo., has resigned his position.

L. E. Rhodes has purchased the business of the Des Jardins Type Justifier Co., Hartford, Conn., and will begin the manufacture of high-grade special machinery and tools.

The C. W. Hunt Co., West New Brighton, N. Y., received the gold medal at the Dusseldorf exhibition for the "Hunt" conveyor manufactured by them.

The National-Acme Mfg. Co., Cleveland, O., announce the opening of a New England office at 45 Oliver St., Boston, Mass., in charge of Mr. M. M. Brunner.

The Cling-Surface Mfg. Co., Buffalo, N. Y., report a busy month, with increasing demands from abroad. Shipments of Cling-Surface have been made to England, the Bahamas, Russia, Australia, South Africa and Java.

Hardinge Brothers, Chicago, Ill., have purchased from Messrs. A. W. Gump & Co., Dayton, O., their entire Cataract precision lathe business and will hereafter manufacture this tool under the name of the Cataract precision lathe.

Pawling & Harnischfeger, Milwaukee, Wis., state that the demand for their cranes and hoists is excellent. They have recently booked orders for cranes and hoists from sixteen prominent firms in this country.

The W. P. Davis Machine Co., Rochester, N. Y., report that business has increased steadily. They have outgrown the building erected for them a few years ago. Two buildings in the rear were recently added, but these have proved insufficient, and the store next to them has just been leased.

The Burt Mfg. Co., Akron, O., have equipped a number of mills at the American Sheet Steel Co. with their Cross oil filters and Burt exhaust heads. The large new plant of the Allis-Chalmers Co., West Allis, Wis., has also recently been equipped with Cross oil filters.

The Marshall & Huschart Machinery Co., Cleveland, O., are now occupying their new warerooms, Nos. 24-26 Lake St. Their ground floor is 60x150 feet, and they have installed there a number of electrically-driven machines, manufactured by sixteen firms which they represent, which are in operation.

The Cushman Chuck Co., Hartford, Conn., advise us that to make additional room at their factory they have leased a large store and basement at 189 Allyn Street, near Union Station, to which their general office, with stock of finished chucks, has been removed. This makes available a considerable space in their factory which, together with contemplated additions, will be utilized for new machinery.

The E. Horton & Son Co., Windsor Locks, Conn., manufacturers of the well-known Horton chuck, are adding to their works another large building which, when completed and equipped with machinery, will enable them to more than double their present output. They are among the oldest chuck manufacturers in existence, having been in the business about fifty years.

Charles H. Besly & Co., 10-12 N. Canal St., Chicago, Ill., desire to call attention to their large and varied assortment of seamless brass and copper tubing. Brass rod, sheet, wire and brazed tubing; braziers' sheet copper, soft and cold-rolled copper anodes, brush copper for electrical purposes, German silver sheet, rod and wire are also carried. Their new store building on Clinton Street is progressing rapidly.

The Wilmarth & Morman Co. Grand Rapids, Mich., report that in the month of October their shipments were larger in amount than for any month for a full year past, and included New Yankee drill grinders only: A number of their dry grinders, 11 of their wet grinders, and in addition, 12 drill grinders to foreign countries. Also two of their large Style "G" or "Whale" grinders, the only drill grinder made for grinding drills as large as five inches.

The Philadelphia Pneumatic Tool Co., Philadelphia, Pa., state that their anticipated volume of business for September was fully realized, the sales for that month having been 20 per cent. more than any previous month. Large orders have recently been received from Great Britain, France, Italy and Denmark. Their German representative, Mr. Chas. G. Eckstein, is now in this country and will probably remain for some weeks.

MACHINERY.

January, 1903.

IMPORTANT GAS-ENGINE INSTALLATION.

THE FIRST OF TWENTY-FOUR ENGINES AGGREGATING 40,000 H. P. NOW IN OPERATION AT BUFFALO—BLAST FURNACE GAS USED.

The illustration on this page is of a 1,000 horse power gas engine of the Koerting type, well-known in Europe, recently built by the De La Vergne Refrigerating Machine Co., New York, for the Lackawanna Steel Co., at Buffalo. This fact in itself may have no special significance, but there are certain features connected with this installation which make the engine of unusual interest and possibly of sufficient importance to say that it marks an epoch in gas engine construction in this country.

A gas engine of 1,000 horse power cannot at the present time be said to be unusual, as several machines of about this power have been built in America and quite a large number are in use in England and on the Continent. This particular machine, however, is the beginning of what will be the largest gas-engine plant in the world and, furthermore, the plant will be operated by the waste gases from the blast furnaces of the steel company instead of by producer gas or natural gas, as has heretofore been the case in this country. We are informed that the Pennsylvania Steel Co. are also installing a blast furnace gas-engine plant, so the movement toward larger gas engines, operated by blast-furnace gas, appears to be well established.

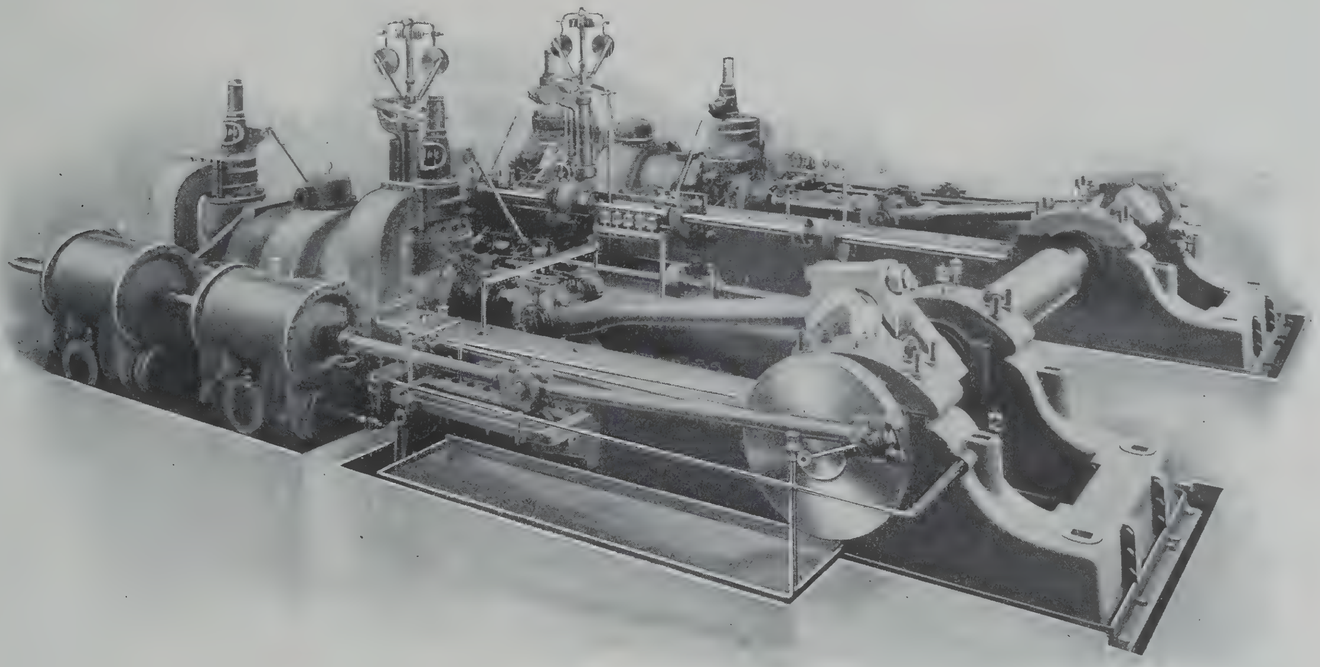


Fig. 1. Koerting Gas Engine of 1000 H. P., built by the De La Vergne Refrigerating Machine Co., New York, for the Lackawanna Steel Co., Buffalo. There will be eight Engines of this size and sixteen of 2000 H. P. each, all Operated by Blast Furnace Gas.

The Lackawanna Steel Plant.

The plant of the Lackawanna Steel Company, where the Koerting engines are being installed, will be the largest individual steel plant in the country, if carried out as now projected. The Lackawanna Steel Company was formerly of Scranton, Pa. It was decided to move to Buffalo, however, and something over a year ago work was begun at the new location. The site occupied is on Lake Erie, south of Buffalo, near what is known as Stony Point, and covers an area about 3½ miles long by 1¼ miles wide. The plant will include blast furnaces, Bessemer and open hearth furnaces and a large number of coke ovens, and will be in active operation within three or four months. Some work is already being accomplished while the building operations are in progress. A large machine shop, 500 feet long, has been running several months and work is being pushed on large rolling mill engines for the Lackawanna plant, which were designed by the engineers of the company and are intended to be heavier than any similar engines ever built. Not the least in importance in the great undertaking is a ship canal, extending three-fourths of a mile into the property from the lake shore. It will be 200 feet wide, 25 feet deep, and will be served by ore handlers which will transfer the ore from the holds of vessels in the canal to the storage yard near by. The most impressive sight, however, to one mechanically inclined, is the two large power plants in which are to be located the gas and steam engines for electric generating, for furnishing the blast for the blast furnaces, and other miscellaneous purposes. The larger of the two power houses is 700 feet long and will contain, besides several large steam engines and air compressors, eight 1,000 H. P. Koerting gas engines, direct-connected to two 500 K. W. generators. The first gas engine was erected and started in the latter part of November and ran satisfactorily. It was first tested by compressed air and is now being run by a temporary gas producer plant, pending the completion of the blast furnaces. The other power plant will contain sixteen 2,000 horse power Koerting gas engines, of the same type as the one shown on this page, but will be used for operating blowing cylinders mounted on vertical frames directly over the cranks of the engine. These cylinders are being constructed by the Southwark Foundry and Machine Company, Philadelphia, and the proportions of the machines can be judged by the fact that the total height above foundations will be 31 feet.

The Koerting Gas Engine.

The Koerting engine is a German machine, designed by Ernst Koerting, which operates on the two-cycle plan and is also double-acting. This gives an impulse at every stroke just as in every steam engine. Nearly all successful gas engines have heretofore been of the Otto four-cycle type and single-acting, with an impulse at every fourth stroke. Apart from its connection with the immense power plant of the Lackawanna Steel Co., therefore, and its operation by blast furnace gas, the machine has certain constructive features that will well repay careful study on the part of the student and of the engineer.

In the two cuts herewith will be found sectional views of the Koerting engine, one being a plan view and the other a cross-section taken in elevation. As stated above, the engine is double-acting like a steam engine, hence the crank end and the head end of the power cylinder are similar. The admission valves are located in the valve boxes, which are bolted to the cylinder heads, and no exhaust valves are required, as the products of combustion escape through slots or ports cast in the middle of the cylinder from where the exhaust pipe leads. These slots are covered by the motor piston itself. For this purpose the piston is made very long and is packed at each end by the customary self-closing spring rings.

The combustible mixture is admitted through two double-acting auxiliary pumps, the one for gas, the other for air. These pumps are so proportioned that their combined action always secures the proper mixture necessary for complete combustion and introduces the same to the working cylinder. The compression spaces of the pumps are divided, so that the crank ends of the air pump and gas pump discharge into the crank end of the power cylinder, and the head ends of the pumps discharge into the head end of the power cylinder. The gas and air are compressed by the pumps to about nine pounds per square inch.

Referring to Fig. 2, it will be seen that the piston is at the outer dead point, and that the exhaust ports are exposed toward the opposite or head end of the engine. The instant the piston begins to uncover the exhaust ports, the pressure of the residual products of combustion in the cylinder drops rapidly to that of the atmosphere; when this has taken place, the inlet valve is opened and a fresh charge admitted by the pumps. The valve gear of these is so designed that air only is supplied first, to separate the burnt gases from the succeeding mixture, and afterward gas and air, mixed in proper proportions.

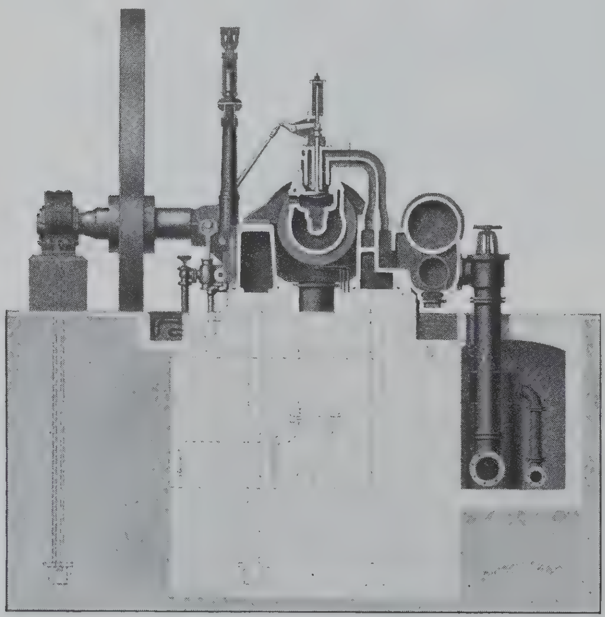


Fig. 3. Sectional Elevation of Koerting Engine.

The combustible mixture of gas and air is produced only at the inlet of the cylinder. There is no storing of it, and by suitable construction of the admission device, mingling of the air first introduced with the burnt residue gases, or with the succeeding charge of the combustible mixture, is adequately avoided. For the same reason, loss of mixture through the exhaust ports, which are open during this period, is prevented.

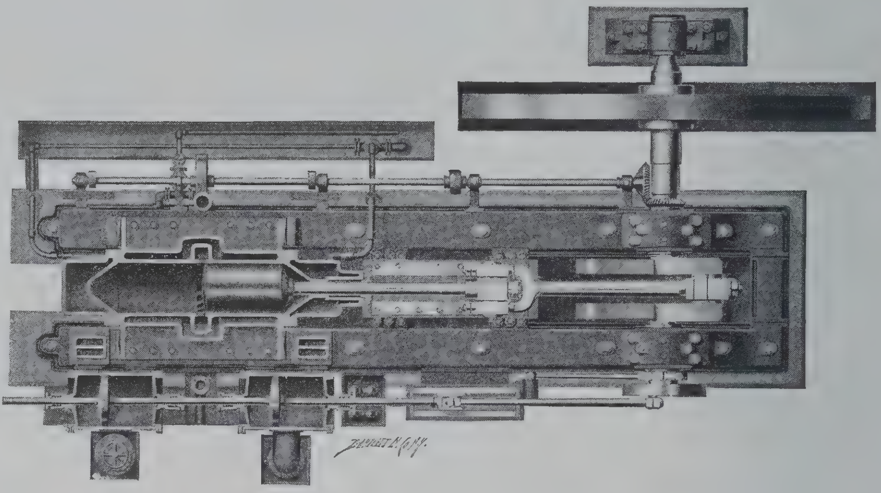


Fig. 2. Plan View of Koerting Gas Engine, taken in Section.

Shortly after the exhaust ports are again covered by the receding piston, the air and gas pump pistons arrive also at their dead point position, and the supply of mixture is interrupted. The inlet valve closes and the charge is compressed in the cylinder in the usual method, till, at the dead point of the stroke, ignition takes place.

At the next movement of the main piston, the ignited charge exerts its driving power by expanding till just before arriving at the other dead points, when the piston uncovers the exhaust ports again and allows the consumed charge to be blown out. On the opposite end of the piston the same operation takes place. This arrangement necessitates the double passages between the small cylinders and the large one, as shown in the two sectional views.

In order to secure the separating layer of air above referred to, between the hot consumed gases and the fresh charge, the gas pump is so constructed that no gas is delivered until after a certain point in its compression stroke. The pump is provided with piston valves with the valve gear so arranged that its maximum capacity cannot exceed 50 to 60 per cent. of its total displacement. For after the pump has completed the suction stroke, the gas suction port is left open during a portion of the succeeding (compression) stroke, so that the gas can return without increase in pressure until the suction port is closed, when the gas is compressed and passed out through the compression port.

The amount of gas thus furnished corresponds to the maximum power of the engine.

Regulation of the power is effected as follows: When the load on the engine is reduced, the gas pump begins to furnish gas at a correspondingly later period, thus discharging a diminished quantity of gas into the working cylinder. This is accomplished either by the valve gear of the pump, and controlled by the governor, or by a by-pass located between each pump end and respective compression channel which leads to the inlet valve on the main cylinder. The throttling device in this by-pass is also under the control of the governor.

It is evident from the above that the engine operates with a variable amount of mixture, and that correspondingly more or less air is sent first into the power cylinder. This air stays near the middle of the cylinder, while the combustible mixture remains at the heads of the cylinder near the inlet valves and igniters. The peculiar shape of the cylinder heads prevents mingling of the layer of air with the following mixture of gas and air.

For ignition there are provided two spark coils at each end of the power cylinder. These are operated by a separate shaft, driven by spur gearing from the cam shaft. The gear on the igniter shaft is not fast; it is connected with a sleeve having a feather, which is set spirally around the shaft so that by a sliding movement of the wheel the igniter shaft may be set behind or in advance of the cam shaft. Thus the time of ignition can be changed during running of the engine to suit whatever kind of gas is being used. A further advantage secured by this arrangement is, that at starting, the point of ignition may be so set that ignition takes place only after the piston has passed the dead point, and the engine started very slowly without incurring any pre-ignition. Very lean gases require much earlier ignition than is otherwise usual. In practice, indicator cards are taken from time to time to check the timing of the ignition, and to see whether the combustion of the gases is without fault. Igniting of very poor gas mixtures presents no difficulties at all with this arrangement. The engine is started with compressed air. Engines to which a blowing cylinder is attached are easily started with air under 150 pounds pressure; for those without such cylinders 90 to 120 pounds per square inch is sufficient.

A piston valve is provided for admitting the compressed air at front and back ends of the cylinder, as in a slide-valve steam engine. This piston valve is operated from the cam shaft by an eccentric, which can be thrown in or out of gear like a clutch. Filling the cylinder with air twice is generally sufficient for starting up, after which the engine runs itself.

The power cylinder and piston are cooled by circulating water, which in the case of the piston enters the tube carried through the crosshead pin and hollow piston rod, and returns the same way, but on the outside of the tube. The stuffing boxes in the cylinder heads are surrounded by water. The cylinder walls also are cooled throughout, except at the middle where the exhaust slots are. By maintaining the piston cooler than the cylinder, the expansion of the former is under entire control and the result is good running of the engine.

The Development of the Gas Engine.

It will be interesting to note in this connection that gas engines were not considered of any importance in this country, or anywhere else for that matter, previous to the Centennial in 1876. At that time the Otto "silent engine" attracted considerable attention and for several years until the patents expired this make of engine was the only one in evidence. Later, many other firms started in the gas engine business but the machines which they built were all of small sizes and all operated on the Otto cycle. For the most part gas engines have been used where only a small amount of power was required and have been run with illuminating gas, thus making a very convenient motor and one which could be located almost anywhere. With suitable modifications they have been adapted to use with gasoline vapor or with natural gas. It was not until 1897 or 1898 that large gas engines began to be built in this country—one of 650 horse power being completed by the Westinghouse Machine Co. in 1899. In fact, it was generally considered that while a small gas engine was a convenient and economical motor, large gas engines would meet with almost unsurmountable difficulties and might never become important competitors of the steam engine.

It is obvious that when operating on the Otto or four-cycle plan, with an impulse at every fourth stroke, an engine of 1,000—or even of several hundred horse power—would require a cylinder of enormous size and other parts in proportion. If operated with illuminating or natural gas, it would involve the handling of large volumes of a highly inflammable gas and there would be occasional violent explosions, which would be positively dangerous. These two facts, drawn from experience with small engines, probably had their influence in delaying the construction of large machines. As has frequently been the case, however, English and other European engineers were ahead of us. They got around the difficulty of the large cylinder by using two cylinders in tandem or two engines in pairs, and by the perfection of the two-cycle type like the Koerting. They also successfully introduced producer gas, which is less inflammable than illuminating or natural gas. Even producer gas in the proportions in which it was first made would not have been successful for large engines because it contained a considerable proportion of hydrogen, which ignites and combines very readily with the oxygen of the air at comparatively low temperatures.

One of the earliest advocates of producer gas was Mr. J. Emerson Dowson, who called attention to its possibility in the *Journal of the Society of Arts*, in 1882.

In 1894 the idea of utilizing blast furnace gases was suggested by Mr. B. H. Thwaite, in England, who showed that its elements and the proportions in which they existed were about the same as with producer gas, and who built a 20 horse power experimental engine to demonstrate the feasibility of the plan. While gas engines will now undoubtedly be used more and more in connection with blast furnaces there is still the objection that blast furnace gas is heavily loaded with dust which will cut the cylinders unless the gas is thoroughly cleansed, and the constituents of the gas are such that it is not easily ignited in the engine cylinder.

Using Blast Furnace Gas.

The usual blast furnace plant contains, in addition to the blast furnace, two blowing engines for producing the blast, three brick stoves (four are used at Buffalo) for heating the blast on the regenerative principle and several boilers for generating steam for the blowing engines. The waste gases from the blast furnace are alternately burned in one or two of the stoves, while the blast is forced through the remaining one or two, previously heated. The process is one of alternately heating and cooling. The waste gases are also burned in the furnaces under the boilers, which latter are generally of simple construction, and not economical in operation, since there is always more gas produced than can be utilized in connection with the stoves and blowing engines. When it comes to using the waste gases in internal combustion engines, a horse power can be produced with one-quarter to one-sixth the quantity of gas consumed per horse power under the boilers in the usual manner, and it is possible to derive enough power to light the works and operate much of the machinery about the plant. This fact being realized, and the large gas engine having proven a success, a new era in power development will be the result.

When the gas leaves a blast furnace it is at a temperature of from 700 to 1,000 degrees, is charged with more or less steam and, as before stated, is laden with dust. Before being suitable for use in a gas engine cylinder the dust must be removed by a scrubbing process, such as passing out through a tank containing coke, through which water runs, or by spraying water on the blades of the fan usually employed to draw the gas through the pipes from the blast furnace and deliver it to the engine cylinders. The gas is also cooled to condense the steam and allow it to separate from the gas, leaving the latter drier and more suitable to use.

The calorific capacity of blast furnace gas is low, as shown by the comparative figures given below:

	British Thermal Units per cu. ft.
Natural Gas	1000
Illuminating Gas	650
Water Gas	450
Producer Gas	125
Blast Furnace Gas	100

While an engine must be larger if it is to be operated by blast furnace gas than if used with a more efficient fuel, its size need not be as great as indicated by the number of heat units, since a much larger charge can be used than with natural or illuminating gases, which are more inflammable.

* * *

The *Electrical World and Engineer* says that a 60,000-volt power transmission line 105 miles long is projected at Guanajuato, Mexico. Power is to be transmitted from a waterfall by the tri-phase alternating system and the line wires are to be supported on steel towers 440 feet apart, making 12 to the mile. The line wire is a cable made up of 19 strands of copper wire having an aggregate section equal to a No. 1 solid wire. The reason for using a cable instead of solid wire is that the tensile strength is increased fully 50 per cent. over the solid wire, and high tensile strength is quite necessary with such long spans. It is estimated that the cost for the tower-supported line will be no more than for a pole line.

SHOP CONSTRUCTION.—4.

FOUNDATIONS.

OSCAR E. PERRIGO.

It is but quoting an old maxim to say that if we are to build a good house we must have a good foundation to build it on. And we may just as pertinently say that if we are to build a good and substantial foundation, we must have something solid to lay it upon. Otherwise we shall be like the man who built his house upon the sands. The diversity of the ground, at the surface and down through the stratifications of material of various densities and strengths, from the solid nature of rock to the almost fluid condition of alluvial soil, must be considered. Each of these conditions requires special treatment according to its nature.

To properly secure a firm bed for the foundation of a building, we must either excavate down to firm and solid ground, technically called "hard pan," or we must by artificial means produce a substantial surface upon which to begin the masonry. It is quite impossible for the architect, the mason or the contracting builder to tell us by a superficial examination of the ground how deep we must go to reach solid ground, or "hard pan." To some extent this may be ascertained by "sounding;" that is, by making small excavations at various points, to obtain the necessary information upon which to determine not only the depth to which the foundation must extend, but whether the nature of the ground renders such artificial support as piles necessary.

It may be found that at some points in the foundation of extensive buildings we need excavate only a few feet, while at others, very deeply; and still at other points the ground may be of such a yielding nature that piles must be driven. Or we may find that the use of piles would be a much more economical method than very deep masonry. But whatever the depth we may be obliged to go to, or the process by which we produce our bed for the foundation, all parts of it must be, not only firm and practically unyielding but level. Hence, when we excavate to varying depths the earth must be "benched out," as it is called, as shown in Fig. 5.

Great care should be taken to have all parts of the bottom of the excavation of as equal density and resisting power as possible, that they may equally support the great weight of the wall to be built. This condition becomes all the more important as the walls of the building are higher and the consequent weights and strains correspondingly increased. It is, of course, true that no ground can be found so absolutely solid as not to yield somewhat when the weight of the building is put upon it, and therefore we must not expect to wholly prevent a certain amount of settling; but we should use all possible care to have this settling as equal as possible over the whole area of the foundation.

Having ascertained the nature of the ground as far as possible, we may determine the kind or kinds of foundation necessary. If the ground is so soft and yielding that excavation to solid earth will have to be very deep, making a stone foundation excessively expensive, piles should be driven as deep down as possible—say, two feet apart, from center to center—and cut off level at the top, and be down low enough to remain always wet. Upon these piles timbers of sufficient size are placed, being laid across each row of piles; then upon these another course of timbers, at right angles to the first. These may be laid close together or two or three inches apart, the size of the timbers being determined by the weight of the wall they are to support. For instance, for the walls of the machine shop proposed in these articles, the timbers may be 10x12 inches laid on edge. Fig. 1 gives a plan view of this method and Fig. 2 shows a cross section of the same. It is not always necessary to arrange the piles in three lines, with those in the center row in line with those of the two outer rows, as shown. Where the weight of the superstructure is not excessive it is often preferable to begin by setting three piles in a row, then two so they will come opposite the intervals of the first row; then, the next row of three in line with the first; then another row of two piles and so on. Where there is considerable depth from the top of the piles without side support it is necessary to drive "sheet piling." Set planks three inches thick, or thicker, with their edges close together so as to enclose the work on both sides, and afterward fill in the spaces between these planks and the solid earth with tightly rammed gravel, and if necessary fill the spaces between the piles with stones or concrete. This will give them quite sufficient support to make a very firm foundation bed and prevent any lateral movement which might result from the bending of the piles.

Timber should not be used under a foundation unless it is in a position to be kept continuously wet by the surrounding soil, for the reason that if always wet enough to exclude the air it will endure for a very long time, but if so situated as to be sometimes wet and again dry, it will soon decay. Therefore, if the use of timber, as above described, is not feasible we must use stone and so arrange the piles, regarding the distances from center to center, as to allow the use of such stones as are available, cutting off the tops of the piles below the water line if possible, or at least so low as to have them always wet. This arrangement is shown in Fig. 3.

Sometimes fairly solid earth may be reached within a reasonable depth, but it requires digging quite a depth beyond this before reaching really solid ground or "hard pan." In such a case it may be advisable to lay down first, a course of concrete four to six inches thick, then a layer of timber and another course of concrete, which will furnish an excellent bed for the foundation. The second course of timber may be replaced by a course of 3-inch planks if the wall is not a very heavy one. Circumstances might also warrant three courses of timber. The width of the timber work should be from two to three times the thickness of the wall. Fig. 4 shows such an arrangement.

A prominent public building has stood for many years on very soft and yielding alluvial soil, upon which such a foundation as that described above was laid over the entire area to be covered by the structure, and many feet deep. Then the stone foundation proper was built upon it, after which the very heavy and massive stone building was erected.

Where excavations vary in depth at different points of the same wall the ground should be cut out in steps, or "benches," so that the bed whereon the foundation is built may be perfectly level. The lower steps should be built in with as large stones as possible and brought up to the level of the more shallow parts. For the larger stones require a smaller number of cement joints and will settle less and consequently, are less liable to disturb the work by yielding unequally. See Fig. 5. In all cases the excavation should be made below the reach of frost.

In building up a foundation of stones they should be laid with as near horizontal joints as possible so as to prevent the lateral movement of the stones by the weight put upon them. They should also be laid as far as possible in courses, and each course leveled off before commencing the next, the thickness of the courses necessarily depending on the thickness of the largest stones. These points are all the more important at corners, where tendencies to disintegrate are the most liable. The foundation is laid considerably wider at the base than at the top, either in a wall gradually decreasing in thickness (that is, technically, with a "batter" of so much per foot, as in Fig. 6) or more commonly by a wide footing of one or more courses of larger stones. Above that it is built with regular vertical faces as shown in Fig. 7.

However the foundation wall may be built, the space between it and the sides of the excavation should be filled in, either by tightly rammed earth or gravel, or better still by "puddling," that is, by flooding the space with water, throwing in the earth or gravel and allowing it to settle, ramming only from six inches to a foot of the top. The foundation of stone should be carried up above the level of the ground, from one to two feet according to circumstances. If the main floor of a building is to be raised several feet above

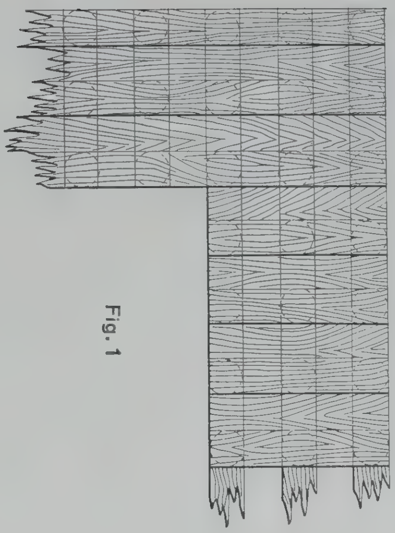


Fig. 1

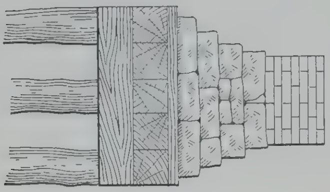


Fig. 2

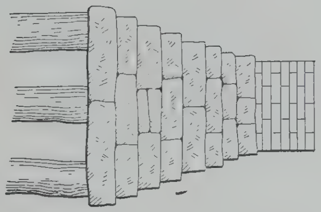


Fig. 3

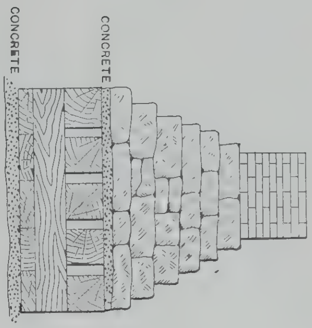


Fig. 4

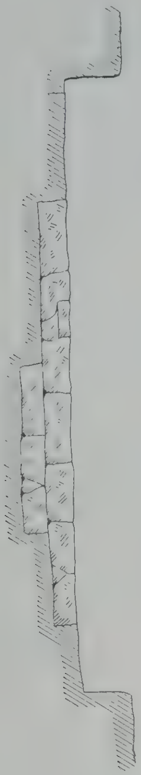


Fig. 5

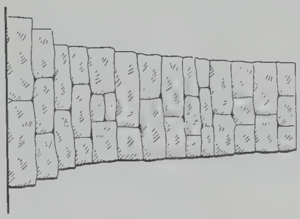


Fig 6

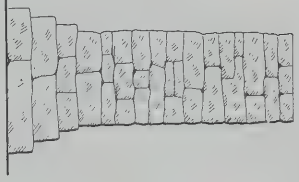


Fig. 7

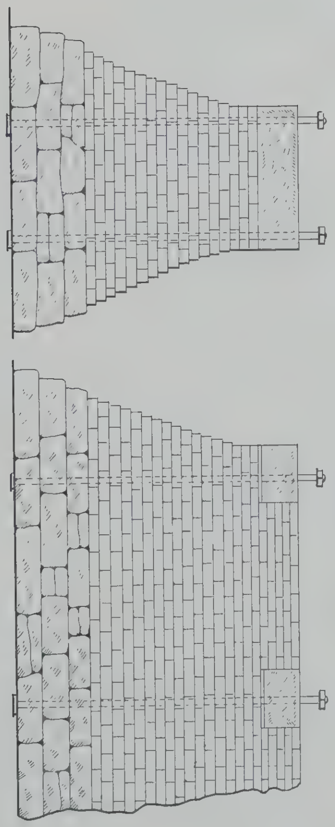


Fig. 8

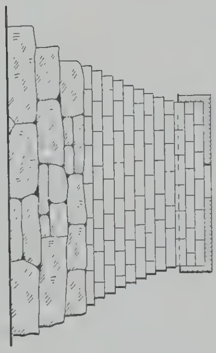


Fig 9

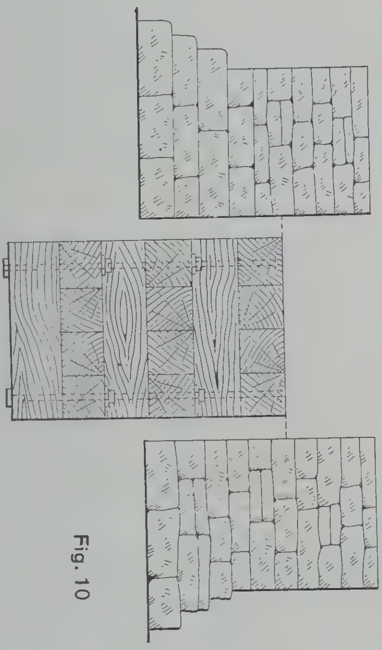
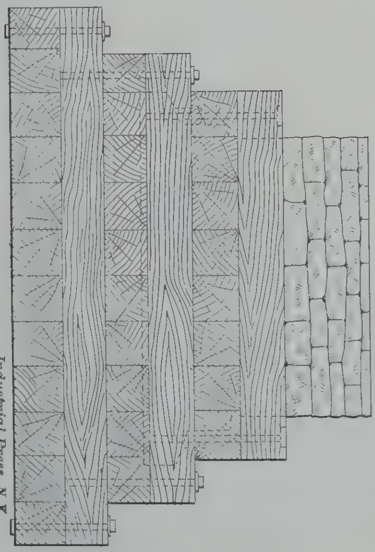


Fig. 10



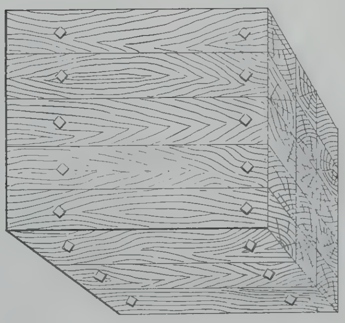


Fig. 11

Sketches Illustrating the Subject of Foundations for Manufacturing Plants.

Industrial Press, N.Y.

the ground level, it is usual to build the foundation high enough to rest the floor timbers upon it, filling in the spaces between them with brick and leveling up ready for the brick wall.

The importance of using strong mortar in foundation work seems to demand that particular attention be paid to the proportions of its ingredients which will make the best compound of its kind. Use two parts of Portland cement, one part of slaked lime, and about three parts of clean, sharp sand. The quantity of sand must be varied according to its fineness, sharpness, and freedom from dirt. A larger quantity of fine sand will be needed than of coarse. Some sand has a more rounded grain instead of the sharp angles of the better quality. Of such sand more must also be used.

Foundations are generally laid in mortar having a greater or lesser proportion of cement. They should also be stronger in this respect for the lower or underground courses than for the upper ones so as to better resist the action of water. In fact much of a foundation is frequently laid in mortar composed of only cement and sand, omitting lime altogether.

Thus far only the foundations for buildings have been considered. These have for their principal object to sustain the weights of the superstructure erected upon them. In the case of the foundations for machinery it is quite different. Here not only the weight must be sustained but the question is complicated by the jars, strains and shocks due to the operation of the machines; and this must also be considered. These vary largely in different cases, as for instance, the steady revolutions of a large lathe, the reciprocating motion of an engine and the vertical concussions of the steam hammer or drop press. Foundations for engines, large lathes, planers, boring mills and so on, are built in a manner somewhat similar to that for the foundation of a building, except that they are usually much broader at the base, conforming in a general way to that shown in Fig. 8. Only a good quality of hard bricks should be used, and the entire work should be laid in strong cement mortar.

The holding-down bolts, when it is necessary to use such fastenings, are made long enough to reach well down in the foundation, if not entirely through it, and are provided with large washers or plates at their lower ends. These are put in place as the foundation is built up and their top ends are held in position by a templet made of boards in the form of a frame, and representing the base of the machine. In a large foundation of this character, blocks of dressed stone should be worked into the finishing courses of bricks so as to bring them level with the top. These are usually placed crosswise, one at each end; and others at such points as to furnish firm support for the cylinder, crank shaft, pillow block, and guides of an engine; for the headstock of a lathe, and for suitable points along the length of the bed; under the uprights or housings of planers and at each pair of legs, or at proper intervals where the entire bed rests on foundations without the use of legs. Usually, in the case of a planer, and often of a large lathe, the foundation is composed of a series of piers built up separately at the points to be supported, each pier being capped by a stone of sufficient size to cover it.

In laying out the foundation for a planer of say, 36x36 inches or larger, a pit should be provided under the center; that is, from a point one to two feet back of the face of the uprights to a point three to five feet in front of the uprights, and five to six feet deep. It should be broad enough for the building of narrow steps leading down into it. This pit will receive a great portion of the chips produced, and in it, resting on large and firmly set stones, should be two cast-iron columns, with strong jack screws tapped into their tops, and coming up into contact with the under side of the bed at a point near the face of the uprights. Thus arranged, they are very useful in maintaining the proper alignment of the planer. A foundation now in use, upon which large lathes are erected and tested, was built as shown in Fig. 9. Solid ground was found about five feet below the floor level, and a course of concrete was first laid, then three courses of stones, and upon these hard bricks, cement being used throughout. Upon the top of each pier a cast-iron plate 1½ inches thick was placed. This plate had downwardly projecting flanges all around it, deep enough to cover three courses of bricks. In the top of these plates was a hole six inches in diameter. When the brickwork was finished these plates were put in place and leveled up so as to leave about half an inch space between the plate and the top of the bricks. Around the lower edges of the flanges the space was carefully closed with cement. Then cement was mixed thin enough to flow easily, and was poured into the hole at the top until the entire space at the top and sides was completely filled, and the whole was allowed to "set." The tops of the plates were about ¼ inch above the top of the floor, which was built up closely around them. Very heavy lathes are moved on and off these piers almost daily without injury, and the piers have not settled to any appreciable extent, or so as to cause any difficulty in leveling up machines to be tested.

In placing high-speed engines or planers, which are liable to lateral shocks, it may be advisable to provide cast-iron plates as described above, with the downwardly projecting flanges to cover the upper courses of brickwork, and also with upwardly projecting flanges enclosing sufficient space for the base, cabinets or legs, as the case may be. After leveling up the machine with steel wedges, say a ¼ to a ½ inch, the space is filled with melted lead or brimstone, which when cool will form a very secure, serviceable and durable arrangement.

Foundations for machines subject to considerable vertical shocks, such as steam hammers, drop presses and the like, must be treated in an entirely different manner. From the nature of the work a solid foundation of stone and brick is not usually considered as best adapted to the conditions. Such a foundation would soon be spoiled by cracks and disintegration from the shocks, and serious consequences to the machine might ensue, the parts broken, for instance, or the dies ruined. For such cases many experienced men prefer foundations that may be elastic enough to relieve the machines somewhat of the sudden strains and shocks of heavy and oft-repeated blows. In these cases the foundations are composed of timbers. There are two common types of these foundations. The first one, for small or medium sizes of drop presses or hammers, are built with timbers set on end and firmly bolted together in sufficient numbers to form a foundation of the required size, as shown in Fig. 11, the bolts going entirely through the mass. Timbers 10 x 10 inches or 12 x 12 inches are a convenient size, and hard pine is found by experience to be best adapted to the work. The excavation is first made to solid ground, then a foot or so of hard gravel is tightly rammed down in the bottom, to form the bed. The timbers are cut of a proper length to reach the surface, but should not be less than five feet long. They are bolted together, lowered into place, and leveled up and good hard gravel is tightly rammed in around the timbers filling the space between them and the sides of the excavation.

This form of foundation is adapted for drop presses and small hammers in which the anvil is a part of the machine itself. In case a hammer is of such size as to have the anvil detached from the main frame, the latter is supported upon a stone foundation, or on one partly of stone and partly of brick (built in two piers for a double hammer), as in Fig. 10. The foundation for the anvil is built of timbers laid horizontally, the base being spread over as large an area as practicable, in order to resist the force of the blows of the hammer. In a double hammer the anvil foundation must be restricted in width, but may be extended in length at the base so as to present the form shown in the engraving.

The size of the foundation is necessarily proportioned to the size of the hammer, but approximately as follows: Supposing the width between the upright parts of the main frame to be six feet, the width of the timber work will be about four feet, the length on top eight feet and at the base twelve feet—assuming the necessary depth to be four feet. If solid ground is not found at this depth, the excavation may be filled up with hard gravel, stone or concrete; or a layer of concrete may be placed at the bottom, then a course or two of stone laid in cement mortar, and finally hard gravel well rammed in. The timbers should be bolted together at the corners or securely spiked, but owing to constant shocks, bolts are to be preferred. The top corners of the timbers should be bolted together horizontally. The masonry piers and timber foundations must not in any way be connected, as the constant concussions would soon disintegrate the masonry. All spaces around the masonry and timber work should be tightly rammed with hard gravel. The size of the timbers may be from 6 x 6 inches and larger according to the size of the structure; but they are usually 10 x 10 inches or 12 x 12 inches. Timbers used in places where decay is feared should be coated with hot gas tar as a preservative.

On one occasion, in soft and very yielding ground, a machine of forty tons weight was supported by a foundation built by excavating nearly 30 feet deep, piles being driven at two feet centers over an area about three times the width and length of the base. Upon these was built a timber structure in the manner described, up to within six feet of the surface of the ground, and gradually drawn in to four feet larger all round than the base of the machine, which was quite high in proportion to its width of base. On this timber work stone laid in cement mortar was built up to the level of the ground and the machine erected upon it. The foundation proved successful.

* * *

NOTES ON CORRESPONDENCE INSTRUCTION.

SOMETHING ABOUT THE WORK OF THE INTERNATIONAL CORRESPONDENCE SCHOOLS, AND OF THE AMERICAN SCHOOL OF CORRESPONDENCE.

The remarkable progress in correspondence instruction during the past few years is the most interesting fact connected with the great educational movement of the present time. It is said there are more correspondence school students in the state of Massachusetts alone than in all the colleges and universities of the whole country. This means that there are thousands of persons, mechanics and others, who do not believe the saying to the effect that a workman is hired to work, not to think. The best mechanics are those who do think, who are well informed, who are well grounded in the foundation principles of their trade; and the same is true, only to a greater degree, as they advance to the higher positions of foreman, superintendent, and so on.

A representative of MACHINERY recently stopped at Scranton, Pa., en route to Chicago, to call at the International Correspondence Schools, and later, when in Chicago, a visit was paid to the American School of Correspondence in their new quarters adjoining Armour Institute. As many readers are personally interested in correspondence instruction it is believed that a brief report from these two institutions will be welcome.

It is generally known, of course, that the International Correspondence Schools are conducting their work on a large scale, but it is doubtful if many appreciate the enormous proportions to which the schools have grown during the few years they have been established. There is now an enrollment of nearly 500,000 students, or nearly half a million, with a rate of increase of about 13,000 students per month. There are 1,200 employees of the schools in Scranton alone. In 1898 a large executive building, of stone and four stories high, was erected for office purposes, also a printing office with accommodations for 200 workmen. But here, as in other departments, the growth has been so rapid as to exceed all anticipations and the buildings were no sooner completed than they were found inadequate, and at the present time additional rooms are rented in every available office building in the city. In the matter of printing, conditions are even more inconvenient. All the new text books are printed in New York City, and all the printing offices of Scranton are assisting in printing the circulars, blanks, etc., used by the schools.

The outcome of the whole matter is that still another new building is being erected for both office and printing purposes, which it is hoped will meet the requirements of the concern, for a time at least, and to provide for the future it is so planned that it can be enlarged to twice its present size. The building will be 460 feet long, 167 feet wide, divided into three bays—one at each end three stories high, and a middle bay 300 feet long, partly one and partly two stories high, where will be installed the printing offices and machinery. Mr. T. J. Foster, the founder of these schools, is taking much pride in having the new building a model of architecture in every respect, that may be held up to the students as an example for their guidance. It is being constructed of Pompeiian brick, both inside and out; the machinery will be motor driven, the elevators of the plunger type, and the power plant will be of the most approved type in every respect, with reserve units for emergency use. This building is perhaps the most interesting feature to report upon at present.

There have, however, been several changes and additions in the courses of instruction and an extensive revision of the papers of all the courses is in progress, including the course in machine shop work to which we have referred in a previous number of the paper. One secret of the rapid increase in the business of the schools is that new courses have been frequently added, taking up different departments of work, and adapting correspondence instruction to new fields where there appeared to be a demand for instruction. There are now 142 different courses, and they include such unusual subjects as the packing house industries, the manufacture of leather and of soap, window dressing, metallurgy of gold, silver and copper, etc., these being mentioned to show the diversity of instruction. Two new departments have been established, the School of Navigation and the School of Textiles, the latter acquired through the purchase of the Correspondence School of Textiles of Bedford, Mass. In preparing the various instruction papers outside writers are employed, if the time of the instructors at Scranton does not permit, or the experience of those intimately connected with commercial work is desired.

There is now being issued, in a library of about 50 volumes, a collection of the best instruction papers upon various technological subjects. As a matter of course the subjects of the various courses overlap to a greater or less extent and it is believed that many would like a reference library, written in elementary style, which treats of the different technical subjects, but without duplication. This library will be added to until it contains upwards of 75 volumes. In preparing these, special attention is given to the illustrations, as will be appreciated by those who have seen the International Correspondence School papers, which are probably the best illustrated of any technical books at the present time, not excepting books by our best publishers.

The American School of Correspondence.

The American School of Correspondence at Chicago, recently removed from Boston, is pleasantly located in buildings adjoining Armour Institute of Technology and owned by the Armour interests. The offices are novel in that they occupy what were formerly apartments, or flats, two whole apartment buildings having been secured for the purpose. They make an almost ideal arrangement, however, for so diversified a business as correspondence instruction, where there are many departments and private offices are needed by the various instructors.

As most of our readers are probably aware, this school is trying a new and important experiment in correspondence instruction. The removal from Boston to Chicago was because of arrangements by which the correspondence method of the American School of Correspondence is to supplement the work of Armour Institute; or more properly, perhaps, is to be supplemented by the work of the institute, in so far as students of the correspondence courses are able, through their preparation, to profit by the superior advantages of a residence course at Armour Institute. It is proposed that a student shall have the opportunity of enrolling in the school of correspondence with the idea of eventually completing his studies as a regular student at Armour Institute.

The arrangement by which the two schools are to cooperate in offering instruction has been in effect for so short a time that it is impossible to estimate at present to how great an extent the correspondence studies may be made of service to prospective Armour Institute students. Before the full benefit of the arrangement can be secured some of the papers of the correspondence course must be rewritten to conform to the instruction given at the institute, and this work will be under the supervision of the Armour Institute faculty. It must be remembered that as the correspondence courses now stand they are intended to give elementary instruction of a more or less superficial character, adapted to the needs of the workman with limited education. They were prepared from an entirely different standpoint from the courses of a technical college.

There are three different departments or grades of study under the direction of the Armour Institute. First and most important is the School of Engineering, corresponding to the best technical colleges, which give a degree upon the satisfactory completion of four years of study; second, is the Academy, of high-school grade, which equips students to enter the school of engineering; and lastly the Armour Institute evening school.

It is not expected that a course of correspondence will enable a student to cancel any of the studies in the school of engineering, as it is desired for the present, at least, that a person shall spend four school years at Chicago, before receiving his degree, so that he may come into intimate contact with the instructors and derive the full benefit of the laboratory instruction. What will be accomplished, however, and is now to a considerable extent, is to apply as much of the correspondence instruction as possible to prepare a student to enter the school of engineering without taking the course in the academy. It is believed that a person will be able to fully qualify to enter the institute in this way, and at the same time his correspondence studies will make his residence course easier for him and possibly enable him to take other additional studies that he could not otherwise complete. A course in correspondence will also enable a student to cancel certain studies given in the evening school.

The papers that are now being prepared for the correspondence schools are being written by outside authorities, for the most part, or by Armour Institute instructors, and the custom is adopted of putting the author's name on each paper. This experiment in technical instruction is similar to what is being done with success by the University of Chicago in general studies, and it will be carried along on conservative lines and, we believe, strictly on a high plane.

* * *

INTERNALLY AND EXTERNALLY FIRED BOILERS.

The art of steam making is one that has probably received as much attention from inventors and engineers as any other, yet there seems to be a general misunderstanding, on the part of many practical men, of the laws that govern combustion and the best way to absorb the heat from a fire into the water of a steam boiler. The common and mistaken idea is that the water-backed surfaces should be as close to the fire as possible and preferably that they should surround the firebox on all sides. This is a mistake. Economical steam-making requires that: 1. The fuel be burned at the hottest possible temperature. 2. That the heat of the fire be absorbed by water-backed surfaces after combustion is practically complete. To burn the fuel at the hottest temperature the fire must be removed from refrigerating effect; that is, it must not come in contact with water-backed surfaces until combustion is complete.

In a circular of internally-fired boilers recently received, some strong claims are advanced for this type which occasion these remarks. The internally-fired boiler is claimed to be superior to the externally-fired type requiring a brick setting because as the fire is surrounded on all sides by water-backed surfaces, there cannot be so much loss of heat as with a brick setting. The externally-fired boiler is referred to as being a modification of the camp kettle with the addition of a masonry setting which absorbs and radiates much heat, etc. No one can deny that the internally-fired boiler has many good points nor that it is indispensable for marine, locomotive, portable or similar service where brick settings would be impracticable, but the fact remains that the internally-fired boiler must work under conditions that do not favor perfect combustion. The water-backed surfaces surrounding the firebox reduce the firebox temperature and the gases escape into the flues only partially consumed. The tubes cool the temperature of the gases still more, so that they finally escape in a partially consumed state—smoke.

The ideal boiler setting is one in which the fuel is burned in an isolated furnace constructed of firebrick and properly protected to prevent radiation. From this sort of firebox the hot gases are conducted against the water-backed surfaces of the boiler to give up their heat. Firebrick piers may be provided in the path of the hot gases, which become red-hot and tend to maintain an even temperature while the furnace is being fired with fresh fuel. Such a furnace when properly constructed will burn the fuel with little or no smoke and in a most economical manner, but we are not saying that such a construction is always desirable or that it is practical under many circumstances because it is not. It takes up a great deal of room and is expensive. In general, however, these conditions may be very well approximated, in the horizontal tubular boiler with brick setting, by building a firebrick arch over the grate so as to prevent direct radiation of heat to the boiler shell. The objection to this scheme is that it is expensive to build and maintain, and that it increases the total height of the setting. The advantages will probably offset the disadvantages in most cases.

In regard to the character of brick work in a boiler setting it has recently been pointed out by a foreign authority that it is better to have the internal surfaces rough rather than smooth. If the surfaces are smooth the gases have a tendency to travel in parallel lines without intermingling, whereas if the surfaces over which they travel are made rough, the mixing of the gases is favored, and consequently more perfect combustion. The irregular surfaces are obtained by simply laying the bricks so that every alternate brick projects half its length into the furnace. Not only do the projecting bricks break up the stream lines, but they become intensely heated and have a regenerative effect, something after the plan of the Siemens steel furnace.

* * *

GOLD DREDGING IN NEW ZEALAND.

In the November issue allusion was made to a novel gold dredging machine which is in limited use on the Pacific coast. This description having come to the attention of Marshall, Sons & Co., who have large works at Gainsborough, England, they have sent us some interesting literature on the subject of gold dredging, from which we quote in substance:

The gold dredging industry originated on the Clutha River in Otago, New Zealand, about the year 1860. The industry has proved immensely profitable in that province, there being upwards of two hundred dredges at work, many of which are paying monthly dividends of 5 per cent., and more. The spoon dredge was the first type of machine used, but this has been generally superseded by the traveling bucket dredge having one central bucket ladder. The bucket ladder is mounted in an inclined position near the center of the dredge, with the lower end, of course, reaching to the river bed from which the traveling buckets convey the mud and sand. The dredges are built self-contained so that the engine, boiler and separation apparatus are all on board. A traveling conveyor carries the refuse to a spoil bank. The buckets usually deliver into a shoot leading to a revolving perforated screen which separates the stones from the fine stuff carrying the gold. The gold-saving tables are efficient and little gold escapes. An example is mentioned where one hundred particles of fine gold were separated and found to weigh less than one-tenth of a grain. The efficiency of the dredging apparatus is so high and the cost of operation so low that it is said to be profitable to work deposits carrying only one grain in weight per cubic yard. Gold dredging machines are profitably worked in the beds of ancient rivers, even if little water is available. Where no water is at hand, it is carried to the scene of operation in pipes. As the water is used over and over again, the volume of water required is not great, after enough is once obtained to float the dredge. A gold dredger is capable of cutting its way into the bank of a river, and this is often done where the river has changed its course. In such cases the river is left behind, sufficient water seeping through the tailings to float the dredge.

A LARGE HOISTING DRUM.

BUILT BY THE NORDBERG MFG. CO.–THE LATHE IN WHICH IT WAS TURNED.

The striking illustrations in this connection are from the works of the Nordberg Mfg. Co., Milwaukee, Wis., builders of steam engines, hoisting machinery, steam stamps, air compressors, and a general line of mining machinery. The Nordberg Mfg. Co. are now occupying their extensive new plant near the city line of Milwaukee, on the Chicago, Milwaukee and St. Paul Railway, and are unusually well equipped in every way for building the varied line of heavy tools for which they are well known. The plant is the result of much careful thought and study and there are numerous features of interest connected with its arrangement and equipment, and with the engineering work in progress, which we intend to refer to in a subsequent number.

At the present time the most important work on hand is a hoisting engine for the Tamarack Mining Co., Calumet, Mich. In its main features and dimensions this will be practically a duplicate of an engine built for the same company about four years ago, which was designed to hoist from a depth of 6,000 feet, or 720 feet more than a mile, and at a maximum speed of 5,000 feet, or nearly a mile a minute. The famous Tamarack mine, for which these machines were designed, has the deepest shafts in the world, and the two hoisting engines are the largest of their kind and in points of efficiency, safety and convenience show the result of engineering skill of a high order. In general form, they have a massive triangular bedplate, with the rope drum and its shaft supported in bearings at the upper apex of the triangle. There are four inclined Corliss engines resting on the faces of the bedplate and arranged in pairs, one pair operating on a single crank at one end of the shaft and the other pair operating on a crank at the opposite end.

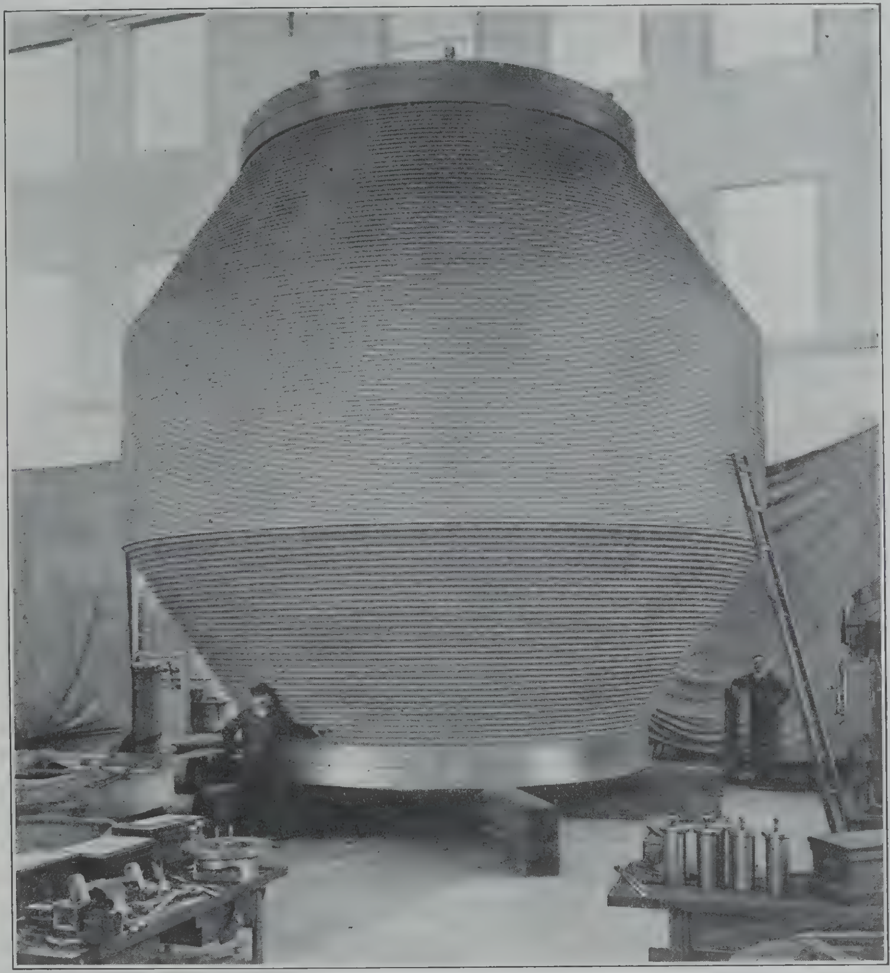


Fig. 1. Rope Drum as it looks Completed. Size, 25 feet Diameter; Length, 24 feet 6 inches. Two 1 1-2 inch Hoisting Ropes, each 6000 feet long, are operated by this Drum.

The rope drum of the first machine had cast grooves for the hoisting rope, but in the machine now building the drum was first turned, to produce a smooth surface like the face of a pulley, and the grooves were then turned out of the solid, making a thoroughly mechanical piece of work. The drum is 25 feet in diameter, 24 feet 6 inches long, and as it stands on end in the shop in the position in which it was photographed for the illustration, Fig. 1, it presents one of the most striking examples of machine work to be found. It is composed of 48 separate segments bolted together, besides the spiders, tension rods, etc., used in supporting it and attaching it to the shaft. The process of turning the grooves on so large a drum is of unusual interest. There are but few boring mills in the country which will take a piece 25 feet in diameter and these are not adapted to turning a spiral groove on the taper ends of a drum. The most feasible plan is to use a pit lathe, and here again much care and patience must be exercised in securing the segmental rings to the faceplate of the lathe in such a way that they may not only be rigid, but may be both turned on their circumferential surfaces and faced on both edges. The various views show how the job was accomplished and are sufficiently novel to warrant careful study.

Figs. 2 and 3 on the next page give an excellent idea of the pit lathe, the former being a side and the latter a front view. One of the conical ends of the drum is in position and the tool is at work grooving it. The lathe was constructed and formerly used at the old plant of the company and when the new works were erected was moved to its present location. It has a massive headstock, placed on a masonry foundation, with a faceplate 15 feet in diameter.

The lathe spindle is hollow, for the accommodation of a large boring bar, so that a pulley or gear may be bored while it is in position on the faceplate. This bar is driven independently of the lathe spindle, by a worm and worm wheel and pulley, to be seen plainly in Fig. 6. The feed mechanism is at the rear of the bar. The lathe spindle is driven by a variable speed motor, on the multiple voltage system. The wire connections and the controller box, together with the motor, appear plainly in Fig. 2. The motor is belted to a pulley at the base of the headstock, near its forward end, and the pulley shaft extends through to the other side of the headstock and drives the faceplate through a train of gears.

There are two carriages and tool blocks provided for the lathe, which slide on ways on top of a heavy cast iron bed shown in Fig. 2. This bed can be moved and clamped solidly in any desired position relative to the lathe. On each side of the pit are long, narrow floorplate castings, anchored to a foundation, which serve as baseplates for supporting the bed. The baseplates have T-slots running lengthwise so that the bed may be clamped in whatever position it is to be located. There are notches cast along the edges of the baseplates and a bar can be inserted in any one of them in order to pry the bed into its position. As it would be somewhat difficult to locate a casting of the size and weight of the slide base with any degree of quickness and precision, especially when turning the taper faces of band pulleys, a taper attachment is fitted to the base and may be employed with either or both carriages. The taper attachment is supported by brackets arranged to slide on ways on the side of the base casting, and it will be noted from Fig. 2 that the attachment proper consists of two long slotted plates, pivoted on the middle bracket, so that the outer ends of either may be moved horizontally one way or the other as required. When turning the face of a pulley, for example, the middle bracket of the taper attachment would be brought in line with the center of the pulley, and the two cam plates swung inward to conform to the taper of each side of the pulley face. Each tool carriage has three adjustments: one in a longitudinal direction along the top of the bed, and two transverse adjustments, by means of two cross-slides. One of the cross-slides has screw and handwheel adjustment and the other is controlled by a projection attached to the cross-slides, which fits in the slot of the taper attachment, the principle being the same as in an ordinary lathe fitted with a taper attachment.

When doing ordinary turning the longitudinal feed for the tools is accomplished by a ratchet mechanism operated by a gear and pinion back of the main headstock bearing, and clearly visible in Fig. 6. When grooving the drum, a coarse, regular feed is necessary and this is secured by means of a chain drive, appearing in Fig. 2. The chain is driven by a sprocket wheel on the lathe spindle, back of the faceplate. An intermediate overhead countershaft makes it possible to connect up to the sprocket wheel on the carriage slide when the latter is placed at an angle, as in Fig. 2. It also facilitates the use of different sprockets for securing different rates of feed.

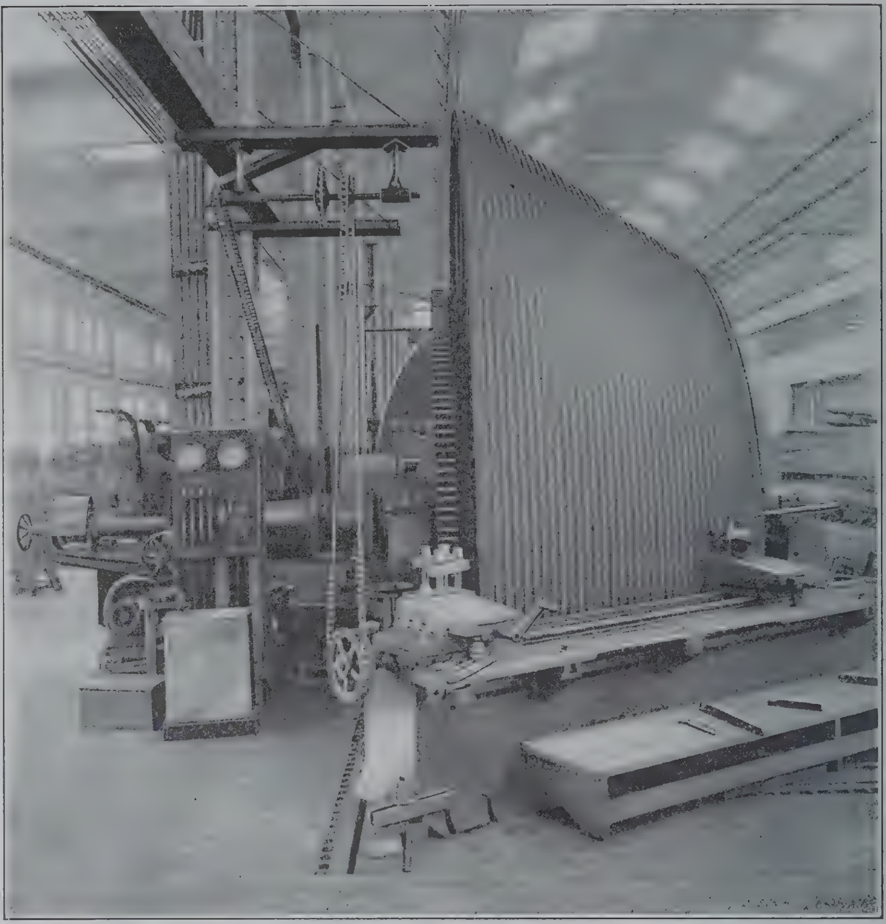


Fig. 2. Side View of Pit Lathe, with Taper End of Drum in position for Grooving.

When work was begun on the large hoisting drum, the lathe was in the old plant and views shown in Figs. 4 and 5 were taken before moving to the new quarters. Fig. 4 shows the lathe at work turning and facing the straight portion of the drum, preparatory to grooving the same, and Fig. 5 shows the grooving operation in process. The straight portion of the drum is built up of two annular rings bolted together side by side and each ring is composed of 12 segments. In Fig. 4 only one ring of segments is in the lathe, the parts of the other ring being piled up at the further side of the lathe. In Fig. 5 both rings are bolted together as one piece and the grooving is continuous from one side to the other.

The two taper sections of the drum are composed of 12 taper segments each, two of which appear in the foreground in Fig. 4, which will give an idea of their size and shape.

It is, of course, somewhat of a problem to properly support the parts of a drum of this size, and the method adopted is quite interesting. The different rings that go to make up the drum are in effect like the rim of a wheel and must be stiffened in practically the same way that a wheel rim is supported, viz., by spokes, which must not only give stiffness to the rim, but must be able to resist the torsional stresses due to the cutting force of the tools. Referring to Fig. 4, it will be seen that a supporting arbor was used, the outer end of which runs in an outboard bearing. There are two sets of spokes for the rim, one set composed of round wrought iron or steel bars like the tension spokes of a bicycle rim, and the

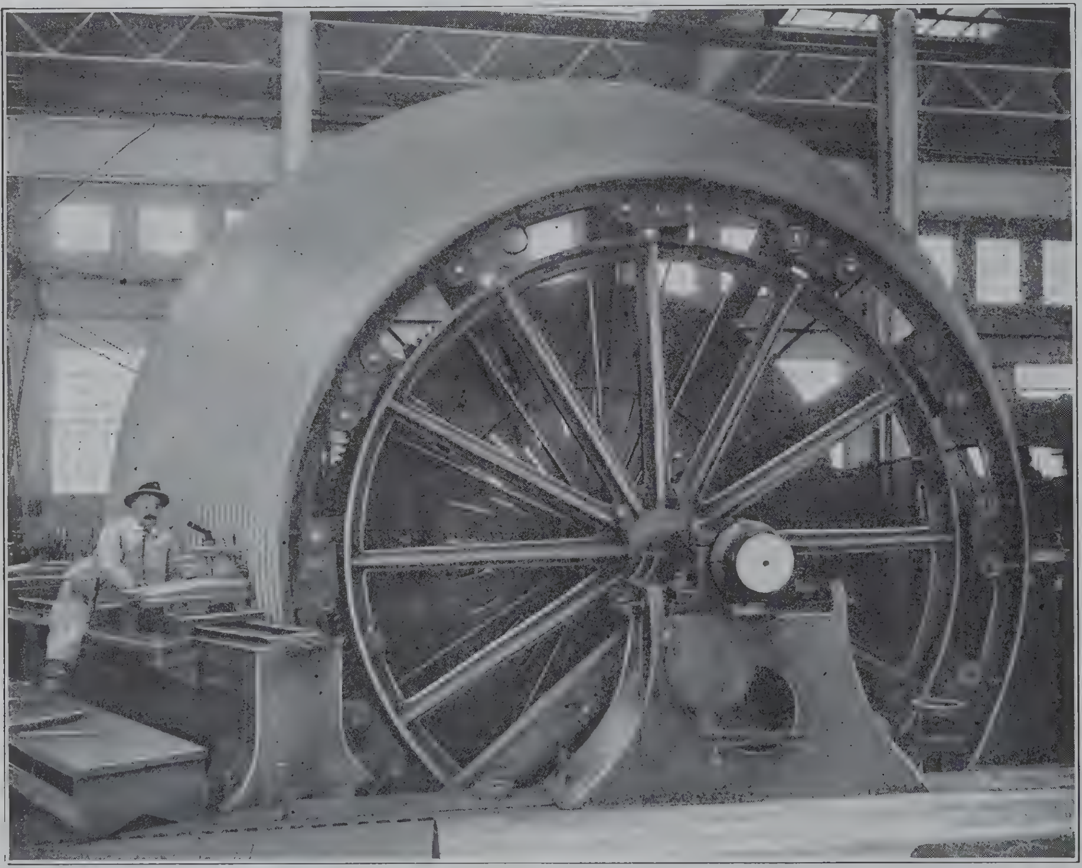


Fig. 3. Front View of Lathe, showing Method of securing the Taper Section of Drum.

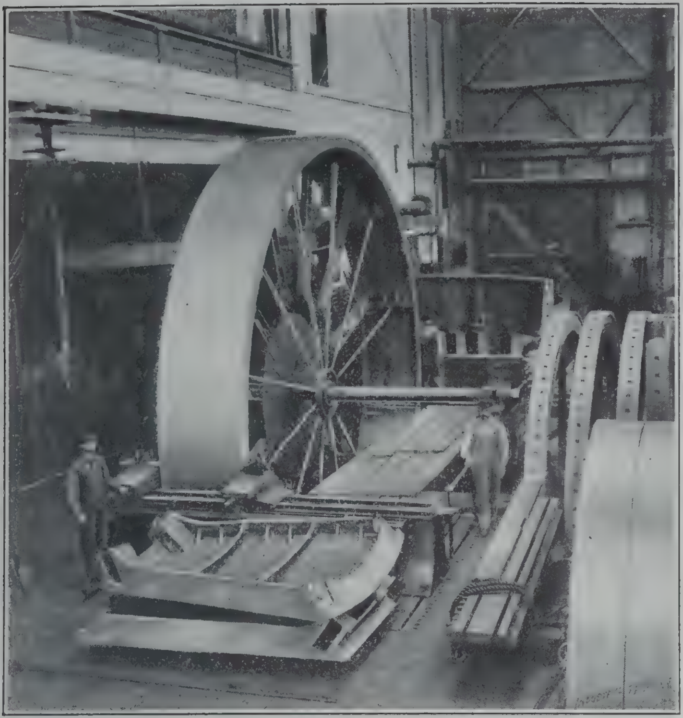


Fig. 4. Turning One-half of Straight Section of Drum.

other set of castings is bolted to the faceplate and made sufficiently heavy to both stiffen the rim and withstand the torsional force. When it came to supporting the wider section of the rim, however, as represented in Fig. 5, an outer spider was placed on the shaft and extension arms were bolted to it like those bolted to the faceplate.

The method of supporting the taper section was identical, except that the spider was of such a diameter that the lugs on its outer circumference could be bolted directly to the flanges on the smaller circumference of the drum.

As mentioned above, this drum is built up of small segments, bolted together, which, while it increases the cost for machining, reduces the labor in the foundry and pattern shop and makes it possible to secure practically perfect castings, an imperfect segment being easily replaced. The method of supporting the drum on its shaft, when in place on the engine bedplate, is different from that usually employed. The shaft itself would ordinarily be made the supporting element and several spiders placed side by side on the shaft would be employed for stiffening the shell and keeping it in position.

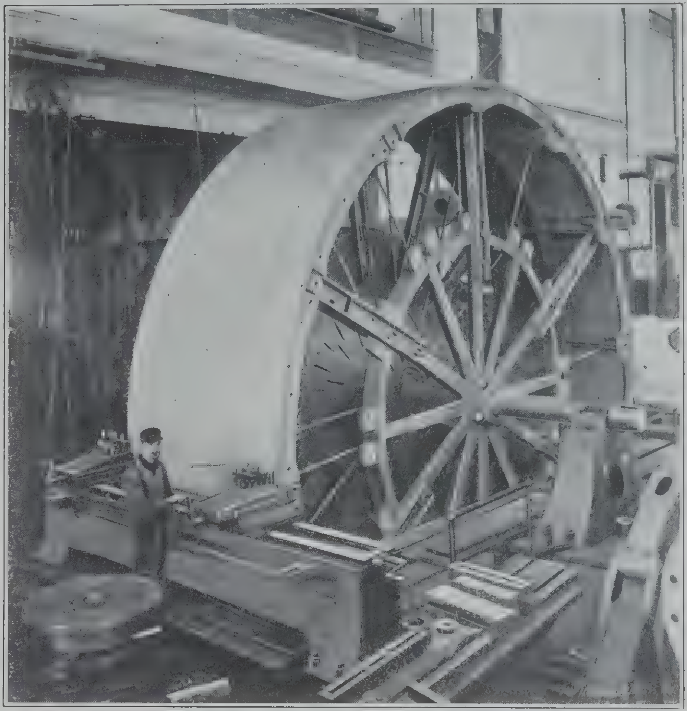


Fig. 5. Grooving Straight Section of Drum.

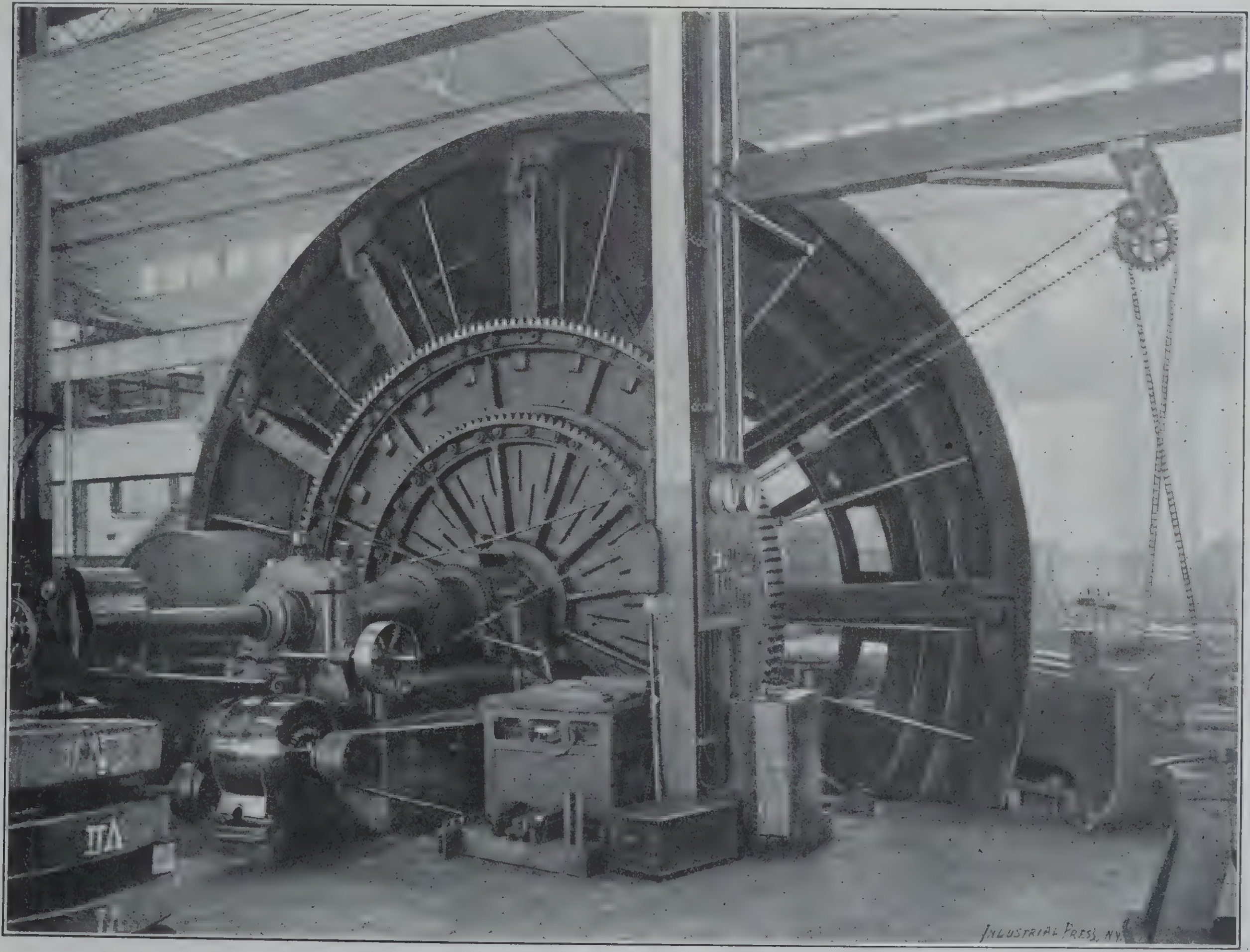


Fig. 6. Rear View of Lathe during Process of Turning one of the Taper Sections.

In the Nordberg drum the supporting element is the shell, which is very rigid, strengthened as it is by the bolt flanges of the different segments. Instead of a series of spiders two flanges or discs are used, one for each end of the drum. These are keyed to the shaft and before being mounted to the shell are brought into parallelism by means of through bolts passing from one disc to the other, thus stiffening the shaft and reducing any tendency to deflection. This being done, the shell segments are placed in position and tension rods are employed to further support the center of the shaft and to increase the rigidity of the drum itself.

It should be mentioned in connection with the drum that the shape in which it is made—taper at each end and straight at the center, as shown in Fig. 1—is a compromise usually adopted with large drums to secure compactness. The hoist is of the balanced type, two cages and two ropes being used, one rope unwinding as the other is wound up. The total weight of one rope when unwound is in this case over 20,000 pounds, or about equal to the combined weights of the cage, cars and ore which are hoisted at one time. When one cage is at the bottom of the shaft the other is at the top and the weight to be supported in one case is therefore double what it is in the other. As one car ascends, the load due to its rope becomes less and less, while the rope supporting the other cage is unwound and the weight due to its rope increases. To keep the cages in perfect balance, so far as the weight of the rope is concerned, and maintain a uniform turning moment for the engines, the drum should evidently be made in the form of two cones, placed base to base. When a cage was at the bottom of its shaft it would be suspended from the small end of its cone, while the other cage, at the top of the shaft, would hang from its cone at its large diameter. Such a design, however, would make necessary a drum of immense proportions, both larger in diameter and longer than the present one. In the compromise adopted the taper portions are carried only half way and each rope in turn winds over the whole width of the straight portion. By utilizing the straight portion for both ropes a substantial saving is made in the length of the drum; and the diameter, of course, is less than if the taper were carried out to the full extent of the rope's travel. When each rope is on the straight portion the ratio of the weight of its suspended part to the weight of the cage and ore is less than when on the tapered portion, and the effect of the compromise is thus not a serious matter.

* * *

LOCALIZATION OF INDUSTRIES.

In the census bulletin upon the localization of industries, issued this fall, is an extended discussion of the reasons that have led to the concentration of industries of a particular kind in certain localities. Numerous tables are given and the conclusion is drawn that there are seven principal causes for the localization of industries. These are: Nearness to materials, nearness to markets, water power, a favorable climate, a supply of labor, capital available for investment and the momentum of an early start.

One of the most important of the above is the nearness to materials, as shown, for example, by the establishment of the paper industry near the spruce and poplar forests, the tanning industry near the chief tanning materials, the manufacture of agricultural implements near the hardwood forests and iron-producing centers. As the location of the source of these materials has changed, so has the location of the industries changed. As for instance the transference of the manufacturing of agricultural implements to the West.

Of scarcely less importance is the nearness to markets although in general the proportion of the cost in transporting finished products on which labor has been expended is not as great as in transporting raw materials. Nearly 48 per cent. of the manufacturing is done in Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania—mainly because when the industries were started the greatest population was in the eastern states. As the center of population has moved westward, however, so has the center of manufacturing.

Nearness of materials and markets, however, mean more than mere geographical distance; they signify, rather, a general accessibility of the markets as effected by the means of transportation. Thus, the development of railroads, or good water power such as canals or rivers, have enabled industries to receive and ship materials cheaply for considerable distances. In the early history of the country, and to a certain extent to-day, industries tend to group near water power and this early tendency has caused them to continue in their original locations, even when otherwise disadvantageous. This is true of the cotton industry, in which power has been used for more than 100 years. At the beginning of the century water power was extensive, and the cotton factories were located along the rivers of New England, and the water supplied 31 per cent. of the power used by them. The desirability of locating near the raw materials, however, and the supposed desirability of cheap labor, have caused a recent movement in this field in favor of southern cities, where new cotton mills are being established.

It will be found that in most cases industries have been established in certain localities either through the habit of industrial imitation or else by chance. It is natural that when a workman has become familiar with a certain industry and is ambitious to go into business for himself he should follow the enterprise in which he has been trained. It is also natural that he should establish his plant where there are already workmen skilled in that particular branch; where he has acquaintance with moneyed men who would be likely to furnish backing; and where there has been a practical demonstration that his line of business can be made successful by proper management. Thus it is that an industry having been started in a particular locality becomes a nucleus about which other industries gather. This is well illustrated in the shoe industry which was established in Lynn, Mass., largely through chance. In the early days there was a settlement of cobblers at Lynn who repaired shoes for that region. In 1750 a skilled Welsh shoemaker came to this country and naturally located there, where he began to teach the art of fine shoemaking and this was the beginning of shoe manufacture, the fame of the place spreading gradually from year to year on this account. Machinery was not used in this industry, however, until the middle of the last century, when steam power was comparatively cheap; and so it is that less than 5 per cent. of our shoes are made by water power. It is interesting to note in this connection that of the industries most localized at the present time are those which require the least use of machinery. The introduction of machinery has tended to lessen the importance of any particular class of labor and has made more important the nearness of buying and selling markets.

Although not mentioned in the report, the shifting of the center of machine tool manufacturing from the east to the west is typical of the changes that have quite generally taken place. Formerly iron and steel came mainly from New Jersey and Pennsylvania, or from abroad. The selling market was in the east and the machine tool centers were at Fitchburg, Worcester, Newark, Philadelphia and other eastern cities. The large proportion of labor cost and the small proportion of material cost entering into such tools have made it possible for these centers to hold their own, and even to increase their output. But with the shifting of the population westward and the development of the iron and steel industries of the west has also come the shifting of the center of machine tool manufacturing to the west through the development of industries in Cincinnati, Cleveland and other western cities.

* * *

A writer quoted in the *American Shipbuilder* says that the fuel consumption of two steamships, one of, say, 8,000 tons displacement and the other of 26,000 tons, will be in the proportion of about 7 or 8 pounds per 100 ton mile for the former as against 5 pounds per 100 ton mile for the latter vessel. This comparison, of course, assumes that the engines are of equal efficiency. When it is considered that the chief item of expense in the operation of ocean vessels is the cost of the fuel, it will at once be understood why these vessels are more advantageous than the smaller ones provided the volume of freight is sufficient to give the large ones full lading. The personnel of the large ship is not much greater in number than that of the small one.

STEEL AND ITS TREATMENT.—5.

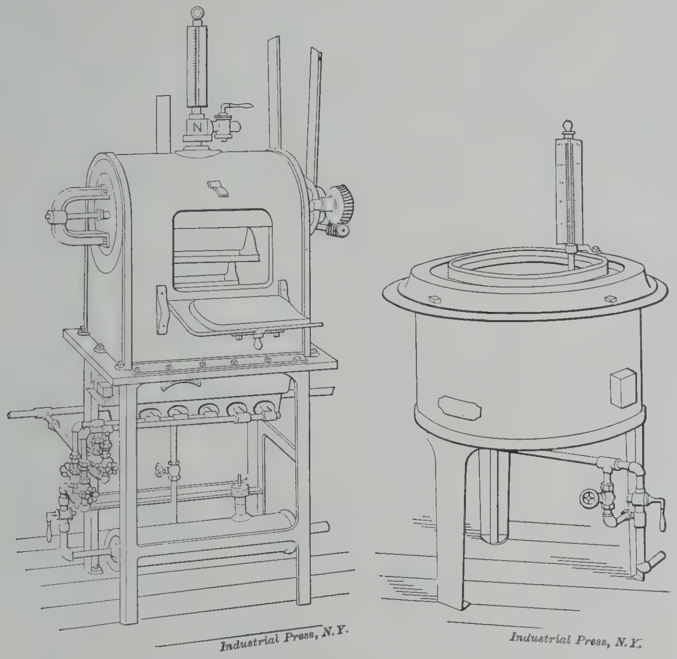
EXAMPLES OF HARDENING AND TEMPERING.

E. R. Markham.

Tool steel is hardened by heating red hot and plunging in some cooling bath; and as previously explained the nature of the bath depends on the character of the work to be hardened. It is necessary that steel used for cutting tools should be hard enough to do the work expected of them, and strong enough to stand up when subjected to the heaviest cuts and feeds they are to take. Now, tool steel suitable for cutting and similar tools, should be of a kind specially adapted for this class of work, and should harden at a *low* red heat.

When hardening, the amount of heat necessary for steel varies with steels of different makes, and with steels of various percentages of *carbon*. To accomplish certain results the steel maker puts other hardening elements into steel with carbon; these steels generally harden at a lower temperature than ordinary carbon steel. The lowest heat at which a piece of steel will harden in a satisfactory manner is called the *refining* heat, because when the piece is broken the grain shows it to have been refined. Steel hardened at this heat is very hard and strong and the grain is the finest possible.

Heating a piece of steel red hot and cooling quickly not only makes it *hard* but also makes it *brittle;* and the higher the heat when the piece was hardened the more brittle the steel will be. If steel is heated higher than at refining heat it is much more brittle. To reduce the amount of brittleness, the piece must be reheated, and this process of re-heating is termed tempering. The process of heating to temper is necessarily a softening one. Ordinarily it is desirable to leave cutting tools as hard as possible, but in this condition they are too brittle to stand up. It is evident that there is nothing gained in heating steel above the refining heat, and then drawing the temper to a degree that makes it much softer than when it came from the bath after quenching at the proper heat. Thus, it will be seen that the ability of a tool to stand up to the work depends greatly on the heat it receives when hardening.



Industrial Press, N.Y.
Industrial Press, N.Y.

Figs. 1 and 2.

To obtain good results steel must be uniformly heated. If one part of a piece is heated hotter than some other part violent strains are set up in the piece, and it is very liable to crack. Uneven heating is probably the cause of a large percentage of the steel cracked in hardening. Heats that are too high cause unnecessary brittleness and open grain.

The methods of heating steel and the baths used in quenching have been considered in former articles; we will now take up the methods ordinarily used in drawing the temper, before proceeding to the hardening and tempering of tools.

The more common way, when the article is taken from the hardening bath, is to brighten one or more of its surfaces with a buff stick. This is made by covering a stick with glue and then adding emery until the surfaces are covered; or a piece of emery cloth may be glued or tacked to the stick, or held on a file. When the steel is exposed to the action of heat various colors appear on the brightened surface. The colors furnish an unvarying guide as to the amount of heat absorbed by the steel. They do not necessarily show how hard the piece of steel may be; because a piece of soft tool steel, or even a piece of iron will show the same colors if brightened and exposed to the same amount of heat. But they do denote the amount of heat a hardened piece has received, and as a certain amount of heat is necessary to produce a desired result (provided the pieces are of an equal hardness to start with) it shows that the amount we reduce the brittleness may be very readily gaged by the temper colors. However, a piece of steel hardened at an extremely low red would not be in the same condition as a piece cut from the same bar and heated to a yellow, even if both pieces were reheated to the same temper color. Here, again, we see the necessity of hardening at the lowest possible heat, and as nearly as possible at the same heat.

The tempering heat may be applied by holding the article over the fire of an ordinary forge, turning it in order to insure uniform heating. Or if the shape of the piece makes it possible, it may be drawn by placing on a hot plate, moving it around and turning it occasionally to heat evenly. Or it may be placed in a pan of hot sand, keeping the sand and articles in motion by shaking the pan. But if the article has teeth or projections which would be injured by striking the other pieces, the pieces may be moved in the sand with a stick, care being taken not to strike them together.

A good method consists in placing them in the revolving pans of a furnace such as shown in Fig. 1. This furnace is provided with a thermometer for gaging the degree of heat in the furnace. The degree of heat registered in this way by the thermometer does not necessarily determine the amount of heat the steel has received; but if one observes the amount registered it serves as a guide, and when it is ascertained what results are obtained with a certain heat these results may be had at any time by heating the furnace so the thermometer registers the required amount. The temperature being no higher than necessary the heavy portions of a piece may be given the required temper without drawing the lighter portions too much.

A method of drawing the temper giving universal satisfaction consists in placing the articles in a kettle of oil, heated to the proper temperature, the heat being gaged by a thermometer, which in this case is partly immersed in the oil, the bulb being at the same height as the work being heated. Furnaces burning illuminating gas, of the pattern illustrated in Fig. 2, give excellent results. But one may be made on the premises at a low cost, that will burn hard coal as fuel. This method furnishes a very cheap means of drawing work done in large quantities, and of doing it very uniformly, as many thousand small pieces may be tempered in a day at a temperature varying not more than one or two degrees.

When very large pieces of steel are to be hardened, some means of heating should be provided for heating the article uniformly, for if the edges and corners are hotter than the balance of the block it is very liable to crack when quenched in the bath, owing to unequal contraction of the piece when cooling. When steel is heated red hot and plunged in a liquid, vapors are formed which have a tendency to keep the contents of the bath away from the work, thus preventing cooling. In order that the liquid may act quickly enough some means must be devised of getting rid of the steam or vapor. When small pieces are being hardened this may be accomplished by moving them up or down, or around in the bath; but, of course, with a heavy piece this would be impossible, so the water or other liquid must be forced against the piece with sufficient force to drive the vapors away and give the liquid a chance to absorb the heat in the steel.

For the hardening of large dies such as those used in drop forge work, a bath may be used having a jet coming up from the bottom, which should strike the face of the die with considerable force. When the die has cooled to the temperature of the bath it is taken out and subjected to heat to remove the tendency to crack from strain. On account of the immense amount of liquid needed for use when hardening work of this description, it is generally necessary to use clear water in the bath. For hardening dies used for punching blanks in punch presses, it is advisable to fill all screw, dowel-pin, and stop-pin holes with fire clay mixed with water to the consistency of dough. This prevents the contents of the bath acting at these points and causing cracks, especially in the holes having threads.

It is extremely important that a die of this kind be heated *very uniformly*, and *no hotter* than is necessary. Dies of this description harden at a lower heat than articles having no openings, even when made from the same bar of steel.

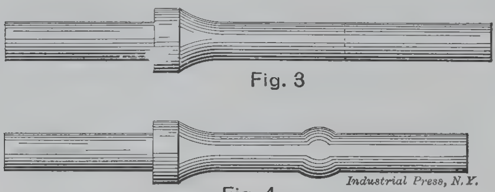


Fig. 3

Fig 4

Figs. 3 and 4. Punch Improperly Hardened.

It is well to dip the die in a bath which has been warmed somewhat, the temperature depending on the shape of the die and the percentage of carbon in the steel. If the die is of a shape that makes it liable to crack when hardened it should not be left in the bath of water until cold, but should be removed when it is hardened on the surface and immediately plunged in a tank of oil and left there till it has cooled to the temperature of the bath. Then it may be heated to remove the tendency to crack from internal strains.

There are various methods used when drawing the temper of dies and similar pieces. The one most commonly used consists in placing the die on a piece of flat iron or steel heated to a degree. Many hardeners heat the plate red hot and place the hardened die on this. It is, of course, necessary to brighten the face of the die previous to drawing the temper in order that the temper colors may be visible. It is also necessary to move the die on the plate and to turn it over occasionally to insure uniform heating, although most of the heat should be applied to the bottom of the die. The amount necessary to draw a die of this kind depends on the steel used in its construction, the shape of the die, the *amount* of heat given when hardening, and the nature of the work to be done by the die. If made of low carbon steel it must not be drawn as much as if high-carbon stock were used; if it were heated above a refining heat it would be more brittle than if properly heated, and consequently would require drawing lower, which would impair its usefulness. If the shape is such that portions of it are weak it must be drawn lower than if it were strong. If it is to receive very rough usage it must be drawn more than if not to be subjected to any great amount of strain.

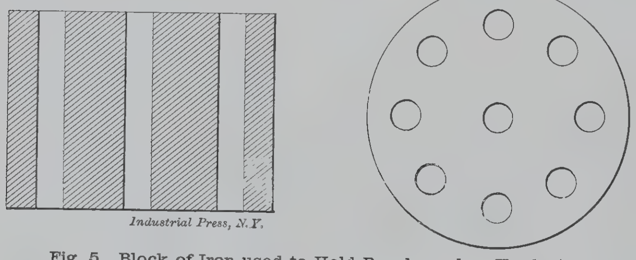


Fig. 5. Block of Iron used to Hold Punches when Hardening.

No given color or degree of temperature can be arbitrarily given as an indication of the proper amount a die should be drawn, as there are so many things to be considered. Sometimes all that is required is to heat them enough to remove the tendency to crack from internal strains, while at other times it may be necessary to draw until the surface is a deep brown with purple spots showing. For ordinary work, however, if hardened at the proper heat a full straw to a brown color will be found sufficient range. The punch to be used with the die should be drawn somewhat lower than the die. When hardening a punch it is necessary to take into consideration its shape and the nature of the work it is to do. If the punch is long and slender as shown in Fig. 3 it is, generally speaking, necessary to harden the entire length of the slender part, to make it as stiff as possible and do away with any tendency to spring. Then again if the punch was to be used in punching very hard stock—that is, heavy as compared to the diameter of the punch—it would be necessary to harden as described, to overcome any tendency of the stock to compress or "buckle." If a punch of the design shown in Fig. 3 were hardened to the point represented by the dotted line, and the balance left soft, it would, if used on stock as large in diameter as the punch, assume the shape shown in Fig. 4; whereas if it were hardened for a distance that made it possible for it to resist the immense pressure, it would remain straight.

When drawing the temper of punches having shanks as shown in sketch, it is customary in some shops to drill holes in a heavy piece of iron as indicated in Fig. 5, and to place the shanks of the punches in these holes having previously heated the block red hot. The heat starting from the shank end travels toward the cutting end. This answers very nicely if the punches are to be used on light or very soft material; but if the stock is heavy or hard, the punch must be about the same degree of hardness the entire length of the portion that must resist pressure. When drawing the temper it may be held in the flame of a gas jet, spirit lamp, Bunsen burner or anywhere that it will be subjected to a sufficient amount of heat to accomplish the purpose. However if there are many punches to be tempered this is costly as well as unsatisfactory, and the furnace shown in Fig. 1 will furnish a means of doing this work with very good results at a reasonable cost per piece. Probably the most satisfactory method consists in heating in a kettle of oil, gaging the heat by a thermometer as referred to under description of oil tempering furnaces, illustrated in cut Fig. 2. The amount of heat necessary to give the pieces when tempering depends on the conditions previously mentioned. It should be borne in mind that slender punches intended for piercing stock as thick as the diameter of the punch are necessarily subjected to immense strain, consequently the steel should be the strongest possible, and this can only be accomplished by careful heating when hardening. If the punch is heated above the refining heat it is more brittle than if properly heated.

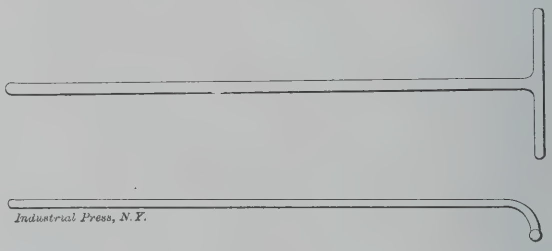


Fig. 6.

Articles that need to be toughened in order to resist strain should, if possible, be heated slowly when drawing the temper; it is advisable to let them cool off slowly also, that is they should not be quenched unless they show a disposition to become too soft, in which case they should be quenched in oil rather than water.

As previously explained, articles of irregular contour, or of a form that causes trouble when the piece is hardened, should, if possible, be annealed after blocking out to shape. Milling machine cutters, especially those of irregular shape, occasion a great deal of trouble in some shops. The teeth projecting from the main body of the stock are much more sensitive to the action of heat than the balance of the piece; consequently they are liable to become hotter than is necessary to obtain good results. If the teeth are hotter than the body of the cutter, then they are expanded more than the other portion, and when cooled in the bath they contract differently, and, as previously stated, unequal contraction is the cause of a large percentage of cracks in hardened steel. If the whole cutter is heated hotter than is necessary, but is heated uniformly, it may not crack, but it will not be as strong as it might be.

It is advisable to heat such tools to the lowest uniform heat possible. When properly heated place on a wire bent at one end in the form of a T as shown in Fig. 6; they should be plunged into a bath of luke-warm water or brine and left there until it ceases "singing," when they may be removed and instantly plunged into a tank of oil and left until cooled to the temperature of the bath. When brightening the teeth in order to readily observe the temper colors, it is advisable to brighten the backs rather than the faces, as in this way there is no danger of injuring the cutting edges.

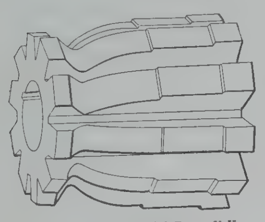

Industrial Press, N.Y.

Fig. 7. Formed Milling Cutter.

It is the general custom in most shops to draw the temper of milling machine cutters by placing them on a plug somewhat smaller than the hole in the cutter, the plug having previously been heated red hot. The cutter should be constantly turned. When the proper temper color shows, the cutter may be removed from the plug and immersed in oil, to prevent its becoming too soft from the heat in the cutter near the hole which was exposed to the red hot iron. The necessary temper at which to draw the cutter depends on the nature of the stock to be milled; however, in most shops they are drawn to a temperature that varies from 430 degrees to 460 degrees, which is equivalent to from a faint straw to a full straw color.

When hardening *formed* mills, Fig. 7, it is not generally necessary to draw the temper, provided the cutter has been hardened at the refining heat. The tooth being heavy is strong enough to resist the strain incident to cutting the stock. Long articles such as reamers, etc., require extra care when heating for hardening. Their diameter not being in proportion to their length makes them especially liable to spring from unequal heating. They are also very liable to spring when dipped in the bath, unless held in as nearly a vertical position as possible. As stated in a former article, stock for tools of this description should never be straightened when cold as it is almost sure to spring when hardened. And the stock should be thoroughly annealed, after the outside surface has been removed. The bath for hardening tools of this description should be heated somewhat; cold baths are very liable to cause springing and cracking. If the articles are so long that uniform results seem impossible to obtain when drawing by the ordinary methods, place them in a pan of oil, heating the oil and gaging the heat by a thermometer as described.

Taps, on account of the weakness of the teeth (threads) which project from the body of the tool, should be heated in a manner that makes them as strong as possible. The teeth must not be overheated, because if overheated they become extremely brittle and break off when in use. After hardening, the flutes should be ground with an emery wheel of the proper shape. This grinding has the effect of giving the cutting portions a sharp edge; it will also break the burrs which form between the teeth from the action of the milling cutter used in cutting the flutes. It also brightens the stock sufficiently to enable one to readily observe the temper colors. If only a few taps are to be tempered they may be heated in a flame, applying the heat to the shank end. If there are many to draw it is best to use a kettle of oil. Taps are drawn to deep straw color for most work.

Hollow mills or similar tools having holes running *part way* through them, should be dipped in the bath with the cutting teeth uppermost, that the contents of the bath may readily enter the hole. Then again it is best to harden the frailest part of such a tool *last*, when possible, for if the weakest part is hardened first it would be rigid by the time the heavier portions were hardened, and the heavier and stronger parts would draw the lighter portions somewhat and these being hard and unyielding would crack.

When tempering these articles heat should be applied at the shank end, allowing it to run toward the cutting edges. If the tool is to cut hard metals a faint straw color will be satisfactory; if softer metals are to be machined it is best to draw to a full straw as they can be forced harder.

Thin saws for cutting metals are hardened by carefully heating and placing between plates whose surfaces are smeared with oil. A flat surface should be provided upon which to lay them when in the fire, which may be accomplished by using a flat plate, either of cast iron or machine steel, one surface of which has been machined flat. This precaution is taken to prevent the piece springing when heating. When it has reached a uniform red heat, which should be as low as possible, the saw may be taken from the fire and laid on the plate mentioned, putting the upper plate on the saw as soon as possible. To place the upper plate in position before the saw has become cooled enough to crook, it should be handled by a second operator. But where very many saws are hardened at a time by this method it is possible to make a fixture consisting of two plates. The lower one is located in a pan of oil and the upper one has a rope attached to it which runs over a pulley fixed overhead. It should then return and be attached to a treadle under the bench. By this means the upper plate can be raised sufficiently to allow the heated saw to be laid on the lower plate, and then the upper one may be lowered onto it. For a fixture of this description two rods, like those shown in Fig. 8 are needed. The lower ends of the rods are stationary with the lower plate. Holes somewhat larger are drilled in the upper one so that the plate may readily be moved up and down.

While it is possible to brighten such articles and draw the temper by observing the colors, if there is a quantity of them it is costly and unsatisfactory. For a large number place in a kettle of oil, drawing the temper to a degree that will adapt the saw to the work it is to do. If it is a metal-slitting saw for cutting tool steel and is to be used in a power milling machine, it may be drawn to 460 degrees; if to be used for general jobbing it should be drawn somewhat lower, say from 480 degrees to 500 degrees. Screw-slotting saws, if 1-16-inch thick or under, show good results when drawn to 525 degrees; if thicker than 1-16-inch they may be left.

When drawing the temper of these articles place them in the oil before it is very hot, as the sudden expansion of a hardened piece of the diameter of a saw used for ordinary machine shop work would cause it to crack. For this reason it is well to put them into comparatively cool oil, heating it to the desired degree, when the kettle may be removed and placed where the work and oil may cool off gradually.

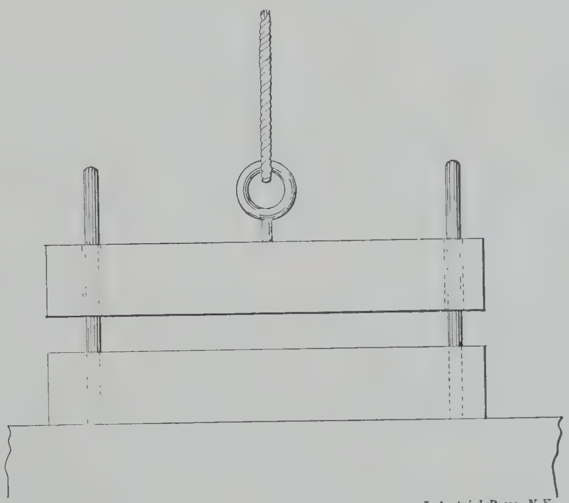

Industrial Press, N.Y.

Fig. 8. Fixture Convenient for use when Hardening Saws.

For the instruction of any not familiar with the various degrees of heat necessary to produce given results when drawing the temper by heating in oil, the following table is given:

	Degrees.		Degrees.
Faint straw color	430	Dark purple	550
Straw color	460	Pale blue	610
Brown yellow	500	Clear blue	570
Light purple	530	Blue tinged with green	630

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

9-15 MURRAY STREET, NEW YORK CITY.

Chicago—1462 Monadnock Block. Boston—620 Atlantic Ave.
Philadelphia—Machinery Floor, The Bourse.

SUBSCRIPTIONS.

Shop Edition, $1.00 a Year. Ten Cents a Copy.
Engineering Edition, $2.00 a Year. Twenty Cents a Copy.
Foreign Edition, $3.00 a Year prepaid.

Lester G. French, Editor.
Fred E. Rogers and Geo. H. Hall, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to The Industrial Press, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1903.

NET CIRCULATION FOR DECEMBER, 1902,—27,423 COPIES.

The entire Engineering Edition is printed on coated paper, and a data sheet containing four 6x9 pages of notes, tables, charts, etc., for note-book use, is furnished with every copy—price $2.00 a year. The Shop Edition is printed on super-calendered paper—price $1.00 a year.

WHAT OF THE LARGE GAS ENGINE?

It is the purpose of Machinery to record from month to month the important steps in the mechanical progress of the times. The most significant event of the past month is the starting of the first of the large gas engines now being installed at the works of the Lackawanna Steel Co., Buffalo, as told in the first article of this number—an installation of exceptional interest in points of novelty, size and in the fact that the engines are to be operated by blast furnace gas.

A conservative estimate of the amount of energy available in blast furnace gas places the number of cubic feet of gas generated, per ton of pig iron produced, at 159,000. Of this, about 50 per cent. must be consumed in heating the blast, and by leakage. If we assume roughly, that 75,000 cubic feet are available for the blowing engines or other power purposes, at the rate of 100 cubic feet per horse-power hour, 750 horse power could be obtained per ton of pig iron. Figures given by W. H. Booth, the English engineer, make even a better showing. He estimates that 96,000 cubic feet of gas can be utilized per ton of pig, and that the engines will run on 91 cubic feet of gas per horse-power hour, giving an available horse power of over 1,000 per ton of iron. It is evident that the resources of a plant having several 400-ton blast furnaces would be very great.

The analysis of blast furnace gas shows it to be composed of the same constituents as producer gas, though in different proportions, the former being richer in carbonic oxide, the heat-giving element. The calorific power of blast furnace gas is only about one-tenth that of natural gas. This is partly because the former has a large percentage of nitrogen, the effect of which is negative, so far as combustion is concerned; and partly because natural gas is largely composed of Marsh gas, which has a calorific capacity of 23,000 B. T. U., as against 4,000 units per pound for the smaller amount of carbonic oxide in the blast furnace gas. The composition of blast furnace gas, however, is not entirely against it when compared with the richer gases, because it is less inflammable, permitting a higher degree of compression in the gas engine cylinder without danger of premature ignition. A larger charge of blast furnace gas can be safely used at each stroke than with natural gas, so that, in spite of the low calorific power of the former, the size of engine cylinder necessary to get the requisite power from the poorer gas need not be as great as would appear.

Statistics, recently quoted by Prof. J. J. Flatner, indicate to how great an extent Europe is ahead of us in large gas engine construction. A list of engines in use or building in the whole of Europe, neglecting those under 200 horse power, shows a total of 327 engines capable of supplying 182,000 horse power, an average of 560 horse power. In the United States in 1899 the total horse power constructed aggregated 165,000, but only nine horse power per engine. There is, however, a constant tendency toward larger work. Gas engines of 1,000 or more horse power each have already been made in this country by the Snow Steam Pump Works, Buffalo, and the De La Vergne Refrigerating Machine Co., New York, and engines of this power are in course of construction by the Westinghouse Machine Co., Pittsburg, and Struthers, Wells & Co., Warren, Pa. Other builders are also producing engines of several hundred horse power.

What are the prospects, then, for the more extended use of large-size engines? Blast furnace gas and natural gas are limited commodities, of course, and the large gas engine must be used with producer gas in most sections of the country. But the economy of the large gas engine with producer gas is not particularly better than the economy of the steam engine of corresponding power, at the present state of the art, reckoning in each case from the coal consumed. The original cost of the two plants—including the producer in one case and the boiler in the other—is nearly identical; and while each *may* develop a horse power on less than two pounds of coal per horse-power hour, we think neither is likely to go much below this figure in ordinary running. Under variable loads we believe the steam engine to be the more economical. In the case of small powers the gas engine, of course, easily leads, since the full economy of steam is not realized with small engines.

* * *

NOTES AND COMMENT.

"It is somewhat amoosin'" to note the attention that has been given by various publications, technical and otherwise, to John Jacob Astor's recent gift to the public of his steam turbine patents. While we do not wish to cast doubts on John Jacob's generosity, we somehow cannot help thinking that the dear public will never reap any great return from his munificence in this particular instance. The design of this turbine appears to one who has given the matter considerable consideration to be highly impracticable to say the least.

The day of small things seems to be fast fading away—at least in the minds of stock jobbers. Some years ago a needle was invented that can be threaded by drawing a loop of the thread along one side, opposite the eye, a narrow slot through the side being provided which makes threading in the ordinary manner unnecessary. Needles can be threaded with your eyes shut. It now appears that this simple scheme is worth an untold fortune and stock is being offered to the confiding public at $10 per share as a RARE investment. From the profits on needles sold in four months, it is calculated that a yearly profit of 60 per cent. will be netted on $1,000,000 capital. Investments *can be* made with your eyes shut, too.

Of course all boiler explosions are not preventable by the exercise of practicable methods of inspection and care, but, in the light of many subsequent investigations, it is quite safe to affirm that the great majority of them are. A city water supply pumping station boiler recently exploded with great violence in Queens Borough, Greater New York, that in all probability did so because of lax methods of inspection. The water used in the boilers was well-known to be of a corrosive nature, yet so lax were the inspection methods that the steel plates of the boiler, originally 3/8-inch thick, were allowed to be eaten away at the water line until they were less than 1-16 inch thick in places. Two men having large families were instantly killed.

Motive power for the machines in a wood-working establishment in Brooklyn is furnished by fourteen induction motors varying in capacity from 5 to 20 horse power. The majority of these motors are mounted overhead upon wooden sleepers bolted to the beams of the floor above. They require no care further than an occasional replenishing of the oil wells. Many of the motors operate in an atmosphere heavily laden with wood dust from the wood-working machinery and are completely covered with this oil-soaked dust but show no injury therefrom. The motors are belted to short line shafts which in turn drive various types of belted machinery, including turning and mounting lathes, circular and band saws, buffers, blowers, drill and machine-shop tools. The motors are started at a reduced voltage by means of starting coils and when near synchronous speed are thrown directly upon the 220 volt system. The power equipment has been in operation for over one year and has been thoroughly satisfactory in every respect.

LION TAMING.

Mr. George M. McCarthy, president of the Hudson County, N. J., Society for the Prevention of Cruelty to Animals, believes that lions come within his jurisdiction. Recently one of these animals has been taking part in a play called "The Lion's Bride" at a Jersey City theater. It was his duty to roar whenever the bride appeared because a Turkish Sultan, whose bride she would not be, had sentenced her to be eaten by the lion. The roar he emitted at sight of the girl frightened the audience, but an animal expert who saw the show informed President McCarthy that the lion's roars were caused by pain and not by anger or a desire to eat the heroine. He also said that he believed the pain was due to electricity. President McCarthy visited the theater and found that the bottom of the lion's cage, which was of iron, was connected with several electric wires that made the lion roar whenever the current was turned on. He notified the manager that the electricity must be omitted, even if the lion refused to roar without it. The order will be obeyed.—*Electrical World and Engineer.*

[Now that the electrician is knocked out in his effort to entertain the public, it remains for some enterprising mechanical genius to devise a roaring apparatus to accompany the lion in his act.—EDITOR.]

WHEREIN NEW JERSEY HAS BEEN FOREMOST.

New Jersey must be credited with influencing the industrial development of the country in other and more substantial ways than by the incorporation of gigantic combinations, by which means it is attracting attention at the present time. In the early history of the country, especially, her citizens figure prominently as leaders in scattering the seeds of future industrial growth.

The first steam engine in America was erected in 1753 at the Belleville copper mines, near Newark, N. J., by Hornblower, 16 years before Watt began his investigations.

The first steam boats driven by single and twin screw propellers were constructed by John Stevens, at Hoboken, in 1802 and 1804.

The Phœnix, the first steamboat to navigate the ocean, was designed, constructed and operated by Jerseymen—John Stevens and his son, Robt. L. Stevens, in 1807 and 1808.

The first charter for a railroad in America was granted by the Legislature of New Jersey in 1814, for a railway from Trenton to New Brunswick during the war of 1812.

The machinery of the Savannah, the first steamship to cross the ocean, was constructed at the Vail Works, Speedwell, near Morristown, N. J., in 1818.

The first locomotive in America to convey human beings on a railway track was constructed at Hoboken in 1825.

The first successful experiments with the electro-magnetic telegraph based on discoveries of Prof. Henry, of Princeton, were made by Vail & Morse, Speedwell Works, near Morristown, in 1838.

These facts were gathered by the curator of the National Museum, for the New Jersey Historical Society.

* * *

The *Engineering News* mentions a well-equipped boiler shop recently built in Alsace, Germany, in which the floor is made of clay mixed with cast iron turnings and borings, the mass being well tamped into place. In front of the workbenches pine flooring on oak joists, is laid.

THE USE OF A SURVEYING INSTRUMENT IN MACHINE SHOP PRACTICE.*

CHARLES C. TYLER.

Many machine shops now have floor surface plates upon which large work is laid out and various machining operations are performed by the use of portable machine tools secured to the plate. The quality of the work produced is largely determined by the accuracy of the laying out, the correctness of the portable tools, and the trueness of the surface plate.

For work having moderate dimensions, scales, squares, beam-compasses, and straight-edges can be purchased in the market sufficiently accurate, if used by careful workmen, to meet the average requirements in laying out the work and setting the portable tools; but for work having large dimensions the scales, squares, beam-compasses, and straight-edges, become quite special, are expensive, and require the utmost care in their manipulation to insure correct work. Ten-foot steel squares and beam-compasses spanning twenty five feet are not easy tools to make or handle, and the fear that errors might be made in some large work to be undertaken at East Pittsburg, led the writer to the consideration of doing away with these abnormal tools and substituting others more easy to manipulate and of a kind to insure accurate results.

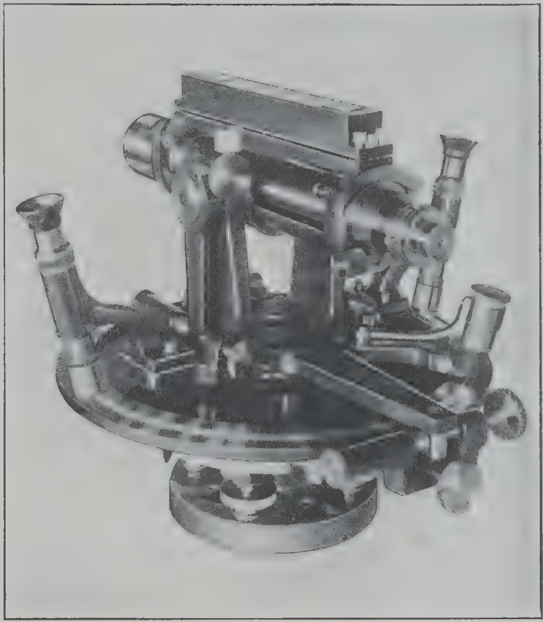

Fig. 1. Surveyor's Transit Designed by the Warner & Swasey Co. for Machine Shop Use.

To carry out the method adopted a dividing and leveling instrument was required, similar in principle to a surveyor's transit, but of special design, adapted to the needs of the machine shop in points of accuracy and convenience. The instrument in use was designed by the Warner and Swasey Co., Cleveland, O., and has a knurled base to be screwed to the cap of a tripod, or in this particular case to a supplementary base with a taper hole by which it can be readily centred on a suitably designed cast iron column which rests upon the floor plate. The knurled base of the instrument has four leveling screws by which, with the usual ball and socket joint and the use of accurate levels it can be adjusted and clamped in a level position. In the center of the instrument are two vertical spindles, one inside the other. The outer spindle carries a horizontal, graduated circle and the inner one a yoke supporting the telescope. The circle is provided with clamps and slow motions by which its O division can be brought to any position in azimuth and there clamped independently of the telescope. The graduations of the circle can be read to 1/10 degrees by two opposite microscopes.

The telescope has an objective one and one-half inches in diameter and is provided with the usual cross-hairs and focusing adjustment. The telescope rests in a cradle which can be revolved about its longitudinal or long axis and has trunnions supported by bearings in the yoke before mentioned. One of the trunnions carries a slow-motion arm which can be clamped at any position for accurate altitude setting. The yoke is provided with clamps and slow motions so that the telescope can be moved to any azimuth position relatively to the graduated circle and independently of it.

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* Abstract from paper read before the December, 1902, meeting of the A. S. M. E., New York.

To illustrate the use of the instrument, let us assume that we have a floor plate, suitable portable vertical slotters or planers, and portable horizontal drilling and milling machines, and that we are to construct a cast-iron ring of over twenty feet outside diameter, properly proportioned. This ring is to be made of six similar sections suitably cored and ribbed, and the operations to be performed are the accurate planing of the joints, cutting the keyways, and drilling the holes for the clamping bolts.

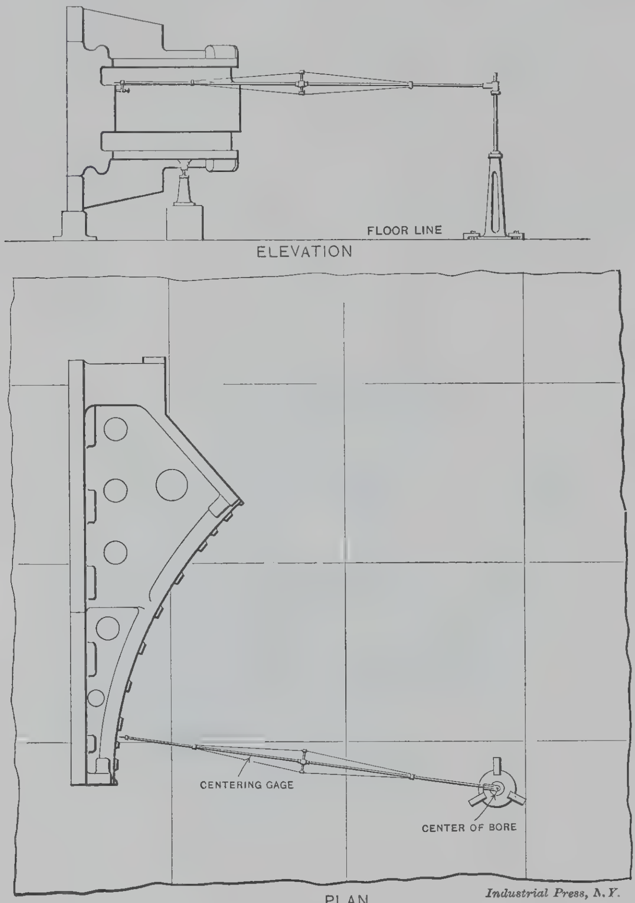


Fig. 2. Locating the Transit on the Floor Plate relative to the Large Casting.

Mount one section upon planed cast-iron blocks about two feet thick and fasten securely to the floor plate, being careful to equalize any warped surfaces found in the casting. The center column is to be moved about upon the floor plate until its exact position in relation to the section has been determined by the use of the centering gage, and the column is then to be securely fastened to the floor plate, where it should remain until all the operations upon the section have been completed. (See Fig. 2.)

Mount the dividing instrument upon the center column, and with the telescope determine the correct position for the zero division of the divided circle of the instrument, to insure equalizing the cut at each joint surface, and clamp the circle in this position. The next move is to secure a straight-edge or parallel to the floor plate in such a position that its front edge is in exact alignment with what is to be one finished joint surface. The location of the straight-edge is determined by the dividing instrument and by the use of a special target which rests upon the top of the straight-edge and has a zero line exactly in alignment with a shoulder which touches the front of the straight-edge. (See Fig. 3.) Another straight-edge is then to be secured to the floor plate under the other joint of the section, and its front edge must be set at exactly sixty degrees from the first straight-edge; its position being determined by the dividing instrument and the special target used in the previous case. The accuracy of the location of both straight-edges being demonstrated by proof surveys, we are ready for planing the joint surfaces.

Planing the Joint Surfaces.

For the joint planing operation let us use a portable vertical slotter or planer having the front edge of its base exactly parallel with the horizontal travel of the tool slide. Secure the portable slotter upon the floor plate with the front edge of its base exactly parallel to the front edge of the straight-edge; the accuracy of the setting being easily determined by a pin gage, and the fine adjustment being obtained by screw jacks bearing against the base and stop lugs inserted in the floor plate. While the roughing cuts are being made upon one joint surface, set a second portable slotter by the other straight-edge in the same manner and proceed with the roughing cuts at this end. In order that the workman may not cut beyond what should be the finished joint surface when roughing, it is advisable to scratch a finish line on the rim section at each joint, but the setting of the tool for its finishing cut is more easily and accurately made by the use of the telescope of the dividing instrument than by any other plan yet tried.

Before setting the tool for the final finishing cut it may be thought advisable to prove the surface of the last cut—a much simpler matter than at first appears. Let us suppose the last cut has left two-hundredths inch stock to be removed and that we have a target with a center line adjustable in a line parallel with one edge. By resting the edge of the target against the surface and adjusting its center line until it exactly cuts the center of the cross lines of the telescope when set at the correct angle, we can survey the joint surface and prove that it is or is not parallel with what is to be the finished joint surface. If the surface be found correct, the finishing cut can be made at once; if there be an error, proper adjustment of the portable slotter must be made and the joint surface again surveyed after taking a light cut. The accuracy of the finished joint surface can easily be determined by the dividing instrument with suitable targets.

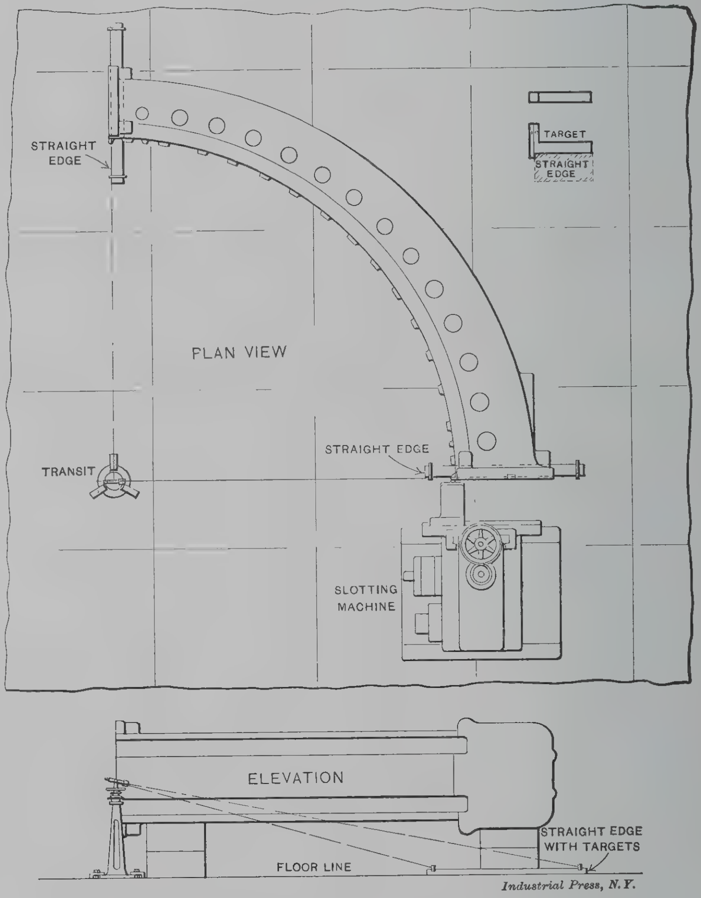


Fig. 3. Adjusting a Straight Edge on the Floor Plate by Aid of the Transit in order to Determine the True Plane for the Finished Surface of the Casting.

Cutting the Keyway and Drilling the Holes.

If the keyway is to be cut parallel with the face of the rim section, the operation can be performed by a portable horizontal milling machine or a portable slotter having a horizontal movement to the tool slide—the correct setting of either machine to be governed by the straight-edge attached to the floor plate, and the exact vertical location of the keyway determined by a surface gage.

If the keyway is to be cut parallel with the axis of the rim section, the portable slotter can be used advantageously and the exact distance of the keyway from the center of the ring determined by a pin gage calibrating from the tool to a pin inserted in the taper hole of the center column.

The axes of the bolt holes should be perpendicular to the joint surface, and they can easily be made so if the front edge of the portable horizontal drilling machine be perpendicular to the travel of the spindle and the base of the machine set parallel to the straight-edges attached to the floor plate. The exact position of each hole is better determined by a jig located by the keyway and a scratched center line; but if the jig is thought too expensive, the holes can be quite easily laid out in the usual way.

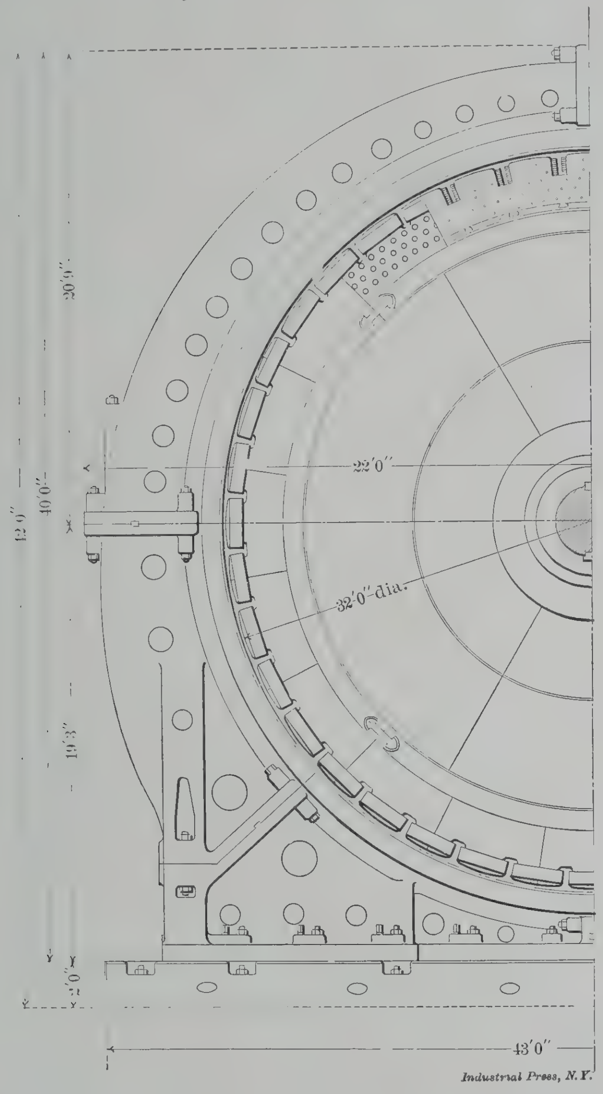


Fig. 4. Showing the Dimensions of a Large Field Frame to be Machined.

For each of the other five sections the same process should be gone through, and it will be found much easier to adjust the center column and straight-edges than to attempt to locate each section.

Testing Portable Machine Tools.

By the aid of the dividing and levelling instrument it is easy to test the accuracy of portable machine tools. In the case of a portable vertical slotter the vertical travel of the tool slide can be determined by setting the instrument so that the cross lines of the telescope exactly cut a line drawn upon the tool block when at its lowest position. Elevate the tool slide to its highest point, tip the instrument, and note the position of the line on the tool block in relation to the cross line of the telescope. If the tool travel is in a line perpendicular to the base, and the instrument has been properly levelled, there will be no variation in the reading. If the tool travel is not perpendicular, the instrument indicates the error, and correction can be made in the portable tool itself or shims can be used under the base to correct the error. To test the parallelism of the transverse travel of the tool slide with the front edge of the base of the machine, set the front edge of the base parallel with a straight-edge secured to the floor plate in a surveyed position—one edge of the straight-edge being approximately perpendicular to the tool slide. Adjust the tool slide until it is exactly perpendicular to the straight-edge by the scratched line as determined by the telescope. A transverse movement of the tool slide to its near and far position will indicate any error; if one be found, it is best to correct the machine by planing or scraping, as may be necessary.

To test the spindle travel of a portable horizontal drilling machine, set the instrument to cut the line of a target attached to the end of the spindle, and survey the spindle in its different horizontal positions. The vertical travel of the spindle slide can be determined by locking the spindle in one position and moving the slide up and down, the same as for testing the slotter. Other portable machines can be tested by similar means, and the result of the tests can be depended upon if the instrument is accurately made and the errors in the subdivisions of the circle are known.

Practical Application of the Method.

The method described has been practically applied to some of the mechanical operations incident to the manufacture of the eight 5,000 kilowatt, alternating current, engine type, 3-phase generators built for the Manhattan Railway Company by the Westinghouse Electric and Manufacturing Company.

The approximate dimensions of some of the principal pieces of one of these generators are shown in Fig. 4. The extreme height from the bottom of the bed to the top of the yoke is 42 feet, and the greatest horizontal distance over all is 44 feet. The bed plate, 43 feet long, has two parts, securely keyed and bolted together, each 21 feet 6 inches long by 10 feet 3 inches wide by 2 feet thick.

The stationary element, or armature, has six principal sections—two lower, two middle, and two upper—all securely keyed and bolted together; the bore being 34 feet, approximately.

The revolving element, or field, consists of many pieces, the principal ones being the cast-steel hub, the two web plates of six pieces each, and the four ring sections. The diameter of this element is 27 feet 8 inches over rim sections, and 32 feet over all.

The total weight of the stationary and revolving elements of this machine (without the shaft) exceeds 1,000,000 pounds, or 500 tons. It is evident from these figures, as well as from the general design of the parts, that very careful machining was necessary and unusual provisions were required to insure success. The principal portable tools used were vertical slotters or planers having a stroke of 8 feet, a small horizontal adjustment of the tool slide, a transverse tool travel of 4 feet —the column having a horizontal adjustment of 4 feet; horizontal drilling machines having a vertical adjustment of 8 feet, the column a horizontal adjustment of 4 feet, with spindle travel of 4 feet; vertical slot milling machines, radial drills, and small vertical slotters.

The principal stationary machine tools were a 14-foot planer, 8-foot open-side planer, radial drills with 10-foot arm, 16 to 24-foot and 16 to 36-foot extension vertical boring and turning mills, 28-foot vertical boring and turning mill, 122-inch engine lathe, a special floor-boring machine carrying portable heads, and several smaller machines.

Bed Plates and Bottom Section.

The bottom and top of bed plates were planed on the 14-foot planer; the joint surface and keyway on the open-side planer, and the joint bolt holes were drilled on the floor plate with portable horizontal drilling machines.

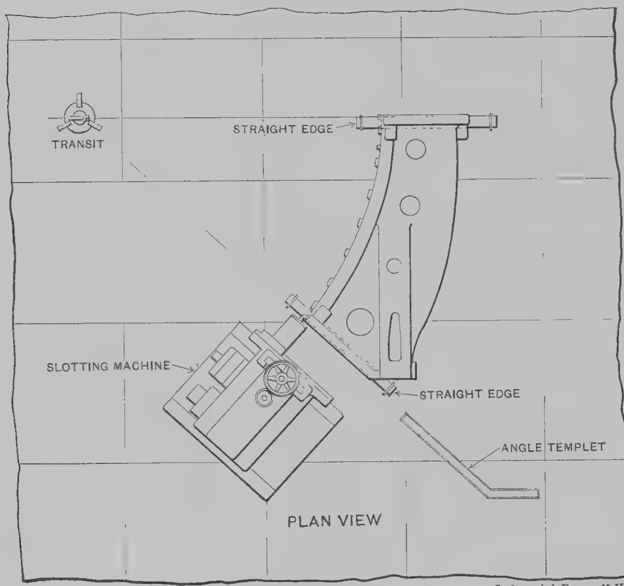
The bottom sections were the most difficult to machine, and a more detailed description of some of the operations on these pieces will make it unnecessary to outline so fully the operations on the other sections.

By referring to Fig. 4, it will be noticed that the lower or perpendicular joint is at right angles to, and the upper joint has a portion parallel to, the bottom or base—the remainder of the upper joint being at a definite angle from the lower joint. The rough casting was mounted on the floor plate, resting on cast-iron blocks, the bottom being set approximately perpendicular to the plate, as shown in Fig. 2.

The proper location of the section involved the making of numerous measurements to insure plenty of stock for finishing—this being particularly necessary for the slot lugs located in the bore. The center column was mounted on the floor plate and its position determined by the centering gage, as shown in Fig. 2, more or less proof testing being necessary to insure its exact location, after which it was securely clamped to the plate.

The perpendicularity of the faces of the slot lugs was determined by scribing lines upon the top surface of the slot lugs with the center gage at the proper elevation, and by lowering the center gage rest or support similar lines were scribed on the bottom surfaces of the slot lugs—scale measurements being accurate enough to prove this setting, after which the bottom section was bolted to the floor plate. The dividing instrument was then mounted upon the column, properly beveled, and finish lines scribed at each joint surface.

Straight-edges were then secured to the floor plate in their exact position—one edge of each being set exactly perpendicular to the desired finished joint surface, the position of these straight-edges being determined by the dividing instrument and a suitable target, as shown in Figs. 3 and 5.



Industrial Press, N.Y.

Fig, 5. Another Application of the Transit—Laying Out the Surfaces to be Planed by the Portable Shaper.

After proving the exact position of these straight-edges, the portable slotters were set in their correct location, secured to the plate, and the roughing cuts taken—slotters often working upon both joints at the same time. The accuracy of the rough planed joint surfaces was proved by the dividing instrument and an adjustable target, after which the cutting tool was set by the instrument for the final radial finishing cut. For that portion of the upper joint of this section parallel to the bottom, the slotter was set by the aid of the angle templet, shown in Fig. 5—a pin gage proving that the tool slide was parallel with the angle templet.

The joint bolt holes were drilled by portable drills, the position of the bolt holes being determined by the use of drill jigs located by keys and by a center line. The drill jigs were made reversible for drilling holes in the faces of the corresponding joint surfaces of the connection sections.

After completing the operations upon the joint surfaces, the lower sections were finished upon the bottom on a stationary planer. The next operation was the drilling of the bolt holes and the drilling and tapping of the adjusting screw holes in the bottom of the section under radial drills.

The operations upon the joint surfaces of the middle and upper sections were laid out and finished in substantially the same manner.

Large Boring Machine and Floor Plate.

The foregoing abstract covers the more important part of Mr. Tyler's paper and illustrates in a very clear manner the method followed in the use of the transit for laying out heavy machine work at the Westinghouse shops. Mr. Tyler next takes up the assembling of the various parts of the armature and field frame, showing how the alignment may be tested as the work proceeds. The frame was first erected in a vertical position on the floor plate and later re-assembled in a horizontal position on a special floor boring machine. The machine consists of a horizontal floor plate 48 feet square, at the center of which is a rotating table, level with the floor, 18 feet in diameter, which carries various tool heads. When boring large work these heads are carried on arms which have sufficient radial adjustment to bore up to 40 feet in diameter. When the frame was first assembled in a vertical position the inside horizontal and vertical diameters were measured; and then when the frame was assembled on the boring machine the same diameters were again measured to determine the extent of the deflection of the upper sections when in an upright position. It was found from the second measurements that the former vertical diameter had increased twelve-hundredths inch and that the horizontal diameter had not materially changed, showing that the deflection was mainly in a vertical direction. By numerous heavy braces and wedges the upper sections were sprung inward toward the center until the diameter corresponded with the diameter recorded during the first assembling, and the frames were then bored, faced and recessed to the required dimensions.

After the preliminary design of these large electrical machines had been determined upon, it was apparent that the buildings, traveling cranes, and machine tool equipment then in service at East Pittsburg were inadequate for the work. A new building was therefore erected, and electric traveling cranes were provided, having ample capacity and mounted on runways of sufficient height to give the crane-bridge the necessary clearance over the top of the generators.

For the operations to be performed by portable tools, and for the erection of the machines, a surface floor plate was considered a necessity, and the one provided is 48 feet wide by 176 feet long; weight, about 2,000,000 pounds. This floor plate consists of 132 cast-iron sections, each 8 feet square, of box section heavily ribbed, keyed, and bolted together—provision being made for the removal of any broken section, should such a mishap occur. The plate, well grouted, rests upon transverse brick piers 12 feet deep, built upon a solid bed of concrete, about 3 feet 6 inches thick. The brick piers are 4 feet apart, center to center, tied together at suitable distances by brick arches, and the space between the piers is filled in to within 5 feet of the under side of the cast-iron plates. The filling between the piers is covered by a layer of concrete, having enough pitch to properly drain into a longitudinal tunnel at one side of the plate. There are numerous rows of drilled and reamed holes for stop lugs, and tee slots extend the whole length of the floor plate, with numerous cored holes at the bottom of the slots to permit the chips to fall through into the transverse tunnels. The main tunnel has trap doors through which the chips can be taken out.

* * *

The American people have been prodigally wasteful of their timber resources, and now that lumber is becoming more and more expensive as the available supply decreases, means are just beginning to be employed to lengthen the life of wooden structures exposed to the weather, like telegraph poles, railroad ties, piles and similar work. Paint is, of course, of no value in preserving wood that is under ground or continually exposed to water action, as in the case of piles. The fiber must be impregnated with creosote or other chemicals of a similar preservative nature. A number of American railroads have recently installed timber preserving plants, some of which are of extensive proportions. The Great Northern Railway has a plant built by the Allis-Chalmers Co., at Flathead Lake, Montana, which has a capacity of 4,000 railroad ties per 24 hours. The three movement zinc-tannin process is used.

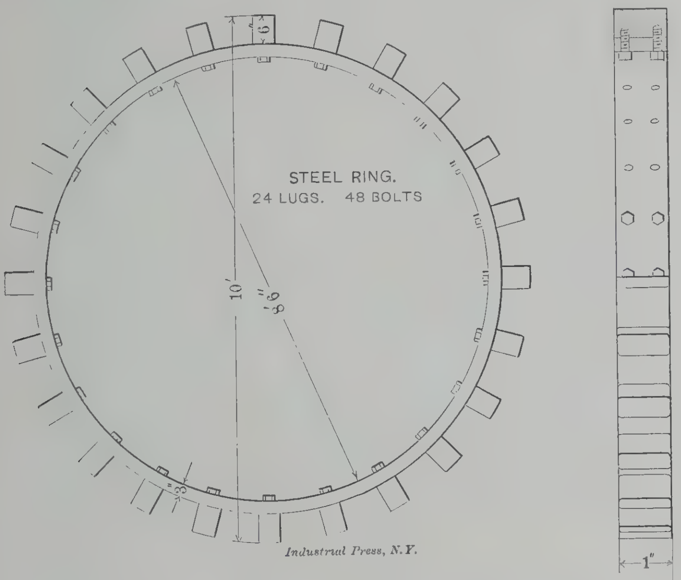
ROTATING RING WITH ATTACHED LUGS.

DESIGN WITH REGARD TO TENSION IN RING AND LUG BOLTS.

Forrest R. Jones.

The limiting speed at which a flywheel may run is generally determined by assuming the tensile stress that the material of which it is made can safely be subjected to, and then calculating either the linear velocity of the periphery, or the number of revolutions, that will cause the assumed amount of stress. In making the calculations for the limiting speed it is quite customary to deal with the rim as if it were free from the arms, thus neglecting their effect upon it. In other words, the rim is dealt with as if it were a plain ring, without attachments, lying on a horizontal table and rotating about a vertical axis coincident with that of the ring. While such an assumption neglects the pulling-in action of the arms and the consequent bending effect on the rim, as well as their tendency to reduce the pure tension in the rim, it is the best that can be applied, for the stresses as they actually exist are so complicated that they cannot be intelligibly dealt with in numerical calculations.

The ring of an electric generator that carries the lugs which form the cores of a rotating magnetic field may be dealt with for determining the tension in it in much the same manner as a flywheel. Such a ring, free from the supporting arms, is represented in the figure. The difference between this and the flywheel rim is that the lugs cause tension in the ring in addition to that induced by its own weight and rotation, and that there are bolts passing through radial holes which cut away part of the material.



Industrial Press, N.Y.

Steel Ring for a Rotating Magnetic Field for Electric Generator.

The speed of rotation that will induce a tensile stress of 14,500 pounds per square inch in the ring, and of 12,000 pounds per square inch in the lug bolts, using the form of ring and other parts shown in the figure, will be calculated. The ring is of forged steel 8 feet 6 inches internal diameter, 3 inches thick radially, and 1 foot wide. The lugs are 6 inches long radially and weigh 100 pounds each. Two lug-bolts are used to fasten each lug to the ring.

The following notation will be used:

C = centrifugal force of one lug, pounds;

$P = P' + P''$ = total tension in rotating ring due to the speed and weight of both itself and the attached lugs, pounds;

P' = total tension in the rotating ring due to its own speed and weight, pounds;

P'' = total tension, due to the speed and weight of the lugs, in the ring, pounds;

V = linear velocity of the rotating ring, feet per minute;

W = weight of the material of the ring, pounds per cubic foot;

a = effective area of bolts for resisting tension, square inches;

d = diameter of the body of the bolts used for attaching the lugs to the ring, inches;

g = 32.2 = force of gravity;

p' = tension, due to its own speed and weight, in a solid rotating ring of 1 square inch cross section;

r = distance from axis of ring to center of lugs, feet;

v = linear velocity of rotating ring at its mean radius, feet per second.

The tension in a ring that is as thin radially as the one now under consideration can be found, with sufficient accuracy for the purpose of designing, for any speed of rotation, by the following formula which gives pounds per square inch:

$$p' = \frac{W v^2}{144\, g}$$

The weight of steel forgings of this description is about 490 pounds per cubic foot. Substituting this value of W and that of g as 32.2 gives

$$p' = \frac{490\, v^2}{144 \times 32.2} = .1058\, v^2 \text{ lbs per square inch.}$$

The cross section of the ring is $3'' \times 12'' = 36$ square inches. The total tension in the ring due to its own weight is therefore

$$P' = 36 \times .1058\, v^2 = 3.81\, v^2 \text{ pounds.}$$

When the ring and lugs are rotating, a point in the middle of the length of the lug, measured radially, moves faster than one at the mean radius of the ring in the same proportion that its distance, 57 inches, from the axis of rotation is greater than the mean radius, 52.5 inches, of the ring. Therefore, the

$$\text{Mean linear velocity of lugs} = \frac{57\, v}{52.5} = 1.085\, v$$

The force necessary to prevent a lug weighing 100 pounds from the flying off the ring when both are in motion is expressed by the equation, in which v is the mean linear velocity of the ring, and r is the distance from the axis of the ring to the center of the lug,

$$C = \frac{100\,(1.085\, v)^2}{g\, r} = \frac{100 \times 1.177\, v^2}{32.2 \times 57 \div 12} = \frac{100 \times 1.177 \times 12 v^2}{32.2 \times 57} = .772\, v^2$$

The total radial pull of the 24 lugs if distributed uniformly around the entire circumference of the ring would induce an

$$\left.\begin{array}{l}\text{Average radial pull}\\ \text{per inch of cir-}\\ \text{cumference.}\end{array}\right\} = \frac{24 \times .772\, v^2}{\text{circum. of ring}} = \frac{18.528\, v^2}{105\, \pi} = .0562\, v^2 \text{ lbs.}$$

This radial pull of the lugs exerts a bursting force upon the ring which has practically the same effect as the internal pressure of confined steam, air or water in a thin shell cylinder, and may be dealt with in the same manner for determining the tension due to it in the ring. The formula applied to this case gives for the total tension in the ring due to the lugs:

P'' = radial force per inch of circumference × radius of ring $= .0562\, v^2 \times 52\ 5 = 2.96\, v^2$ lbs.

The total tension of the entire cross section of the ring is the sum of that due to the speed and weight of both the ring itself and the lugs. It is expressed by

$$P' = P' + P'' = 3.81\, v^2 + 2.96\, v^2 = 6.77\, v^2 \text{ pounds.}$$

Since a part of the material of the ring is cut away by the lug bolts, it is necessary to determine their diameter as the next step in the calculations. The effective sectional area of a bolt such as will be used to hold the lugs in place is that at the bottom of the thread. Since the diameter of these bolts is not yet determined, the exact ratio of the diameter at the root of the thread to that of the body of the bolt is not exactly known. It is on the safe side to assume that the diameter of the body is 1.18 times that of the root of the thread. This is a somewhat larger ratio than actually found for ordinary bolts from 1.75" to 3" diameter of body. Under this assumption a bolt in tension with a body diameter d has an

$$\text{Effective area of bolt} = \frac{\pi\, d^2}{4\,(1.18)^2}$$

Two bolts are to be used for each lug. Their combined tensile strength must be equal to the centrifugal force of one lug. This centrifugal force has been determined as $C = .772\ v^2$ pounds.

The equation between the bolt area and the centrifugal force of a lug, for two bolts in each lug, at a tensile stress of 12,000 pounds per square inch in the bolt, therefore, is

$$\frac{12000 \times 2\,\pi\, d^2}{4\,(1.18)^2} = .772\, v^2$$

Whence

$$d = 1.18\, v \times \sqrt{\frac{2 \times .772}{12000\ \pi}} = .00757\, v$$

The greatest tension per square inch in the ring is where the cross section is reduced by the two bolt holes for one lug. The solid sectional area is here decreased by an amount equal to the thickness of the ring multiplied by twice the diameter of a bolt. Therefore, for a tensile stress of 14,500 pounds per square inch in the material of the ring, the following equation can be written:

$$14500 = \frac{P' + P''}{\text{Effective area of ring}} = \frac{P' + P''}{(3 \times 12) - (3 \times 2\, d)}$$

It has already been found that $P' + P'' = 6.77\ v^2$. That of d may be expressed as $.00757\ v$. By making these substitutions in the last equation, it becomes

$$14500 = \frac{6.77\, v^2}{36 - (6 \times .00757\, v)} = \frac{6.77\, v^2}{36 - .0454\, v}$$

Whence

$$v^2 + \frac{14500 \times .0454}{6.77}\, v = \frac{14500 \times 36}{6.77}$$

$$v^2 + 97.2\, v = 77500$$

This equation can be put into form for extracting the square root by adding 2360 to each side so as to make the left-hand member a complete square. Thus

$$v^2 + 97.2\, v + 2360 = 77500 + 2360.$$

And by extracting the square root

$$v + 48.6 = \sqrt{79860} = 282.5$$

$$v = 234 \text{ feet per second.}$$

Or

$$V = 14040 \text{ feet per minute.}$$

The speed of rotation corresponding to this linear velocity can be found by dividing the linear velocity by the circumference of the ring, whence

$$\text{Speed of rotation} = \frac{14040}{9\,\pi} = 500 \text{ rev. per minute.}$$

The outer diameter of the ring is here used in order to roughly balance the error introduced by using the mean diameter of the ring and the radial distance to the center of the lugs, instead of the correct slightly larger values. The reason for not using these correct values is that it is difficult to determine them, and the error introduced by the method that has been followed is very slight in this case. With a ring thicker radially, or longer lugs, the error would increase rapidly.

The diameter of the bolts may now be determined by introducing the value of v just found into the equation for d developed earlier in the solution. Thus

$$d = .00757\, v = .00757 \times 234 = 1.77 \text{ inches.}$$

A body diameter of 1.75″ would naturally be used in practice.

As a check on the work that has been done, the values of the tensions in the ring and bolts may now be determined by introducing the speed of rotation and bolt diameter that have been found.

$$\text{Net sectional area of ring} = (3 \times 12) - (3 \times 2 \times 1.75)$$
$$= 36 - 10.5 = 25.5 \text{ square inches.}$$

$$\text{Tension in ring} = \frac{P' + P''}{\text{net section}} = \frac{6.77\, v^2}{25.5}$$
$$= \frac{6.77 \times (234)^2}{25.5} = 14600 \text{ lbs. per sq. inch.}$$

A bolt of 1.75″ body diameter has, according to tables of standard threads, an area at the root of the thread equal to 1.746 square inches. Therefore the

$$\text{Bolt tension} = \frac{.772\, v^2}{2 \times 1.746} = \frac{.772 \times (234)^2}{2 \times 1.746} = 12100 \text{ lbs per sq. inch.}$$

These values of tension are slightly higher than actually induced by a speed of 500 revolutions per minute, for this speed of rotation corresponds to a linear speed of the fastest moving point in the ring only as high as was determined for v at the mean radius of the ring by calculation. By making the speed of the mean radius of the ring as high as v was determined, the peripheral velocity would be increased.

There are, of course, bending stresses in the ring due to the localization of the radial pull of the lugs at the points where they are attached; also at the points where the arms of a spider for supporting and driving the ring are attached. As has already been stated, it is practically impossible to determine these stresses. There might be a gain in some cases by making the ring thicker radially where it is pierced by bolt holes, so as to make the cross section at these points as great as between the lugs. This is generally a source of considerable additional cost.

* * *

ANNUAL MEETING OF THE A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers, which opened in New York on the evening of December second, was one of the most interesting in the history of the society; not because of the rare technical merit of the papers, nor of the great value of the discussions, but because mechanical engineers, like other human beings, enjoy a scrimmage, when it becomes animated enough to be interesting. The chief topic up for discussion was the metric system and the subject of the metric system permeated the meetings from beginning to end.

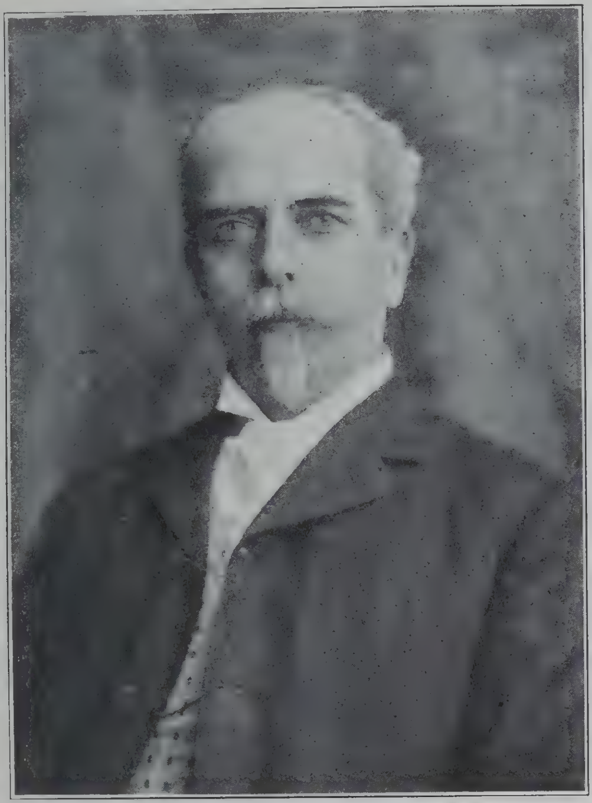
In the absence of President Reynolds, who, according to custom, should have delivered the annual address at the opening session, the first of the technical papers was read by Prof. Reeve, upon a duodecimal system of numeration. Such a system is interesting as a project, and has the advantage that its unit of 12 can be divided by 2, 4, and 3, all factors convenient to use.

On Wednesday and thereafter the sessions were held in the assembly hall at the Sturtevant house, an arrangement that was much appreciated by the members present, for it not only abolished the annoyance of the crowded lecture hall at the society rooms, but it gave much better facilities for serving lunch on the days of the meeting. The Wednesday morning session was devoted entirely to the transaction of business, with Vice-President Waitt as chairman, who showed rare ability in parliamentary matters. The business consisted principally of the report of the council, and the appointment and reports of committees. A committee of four was appointed to serve with four members from each of the other three leading engineering societies, for the award of the John Fritz medal, and committees were also announced for the consideration of standard machine screw threads and to co-operate with committees from other societies to establish specifications for testing materials.

The Committee on Rules and Methods submitted several questions, one being that of the dues and age limit for junior members of the society. This led to an extended debate which did not clarify matters much, until finally a resolution was passed voicing the sentiment that Juniors hereafter elected should not be allowed to remain Juniors after the age of 30, but should be required to become Associate or Regular members, according to their qualifications, and pay the increased rate of dues to such membership; or else be dropped from the rolls. A resolution was also passed calling for a letter ballot of all the members in the case of a change in the constitution or rules.

At the afternoon session the metric system discussion began. Mr. F. A. Halsey presented his paper upon the subject, which was the opening gun—one of large caliber—for he presented what are perhaps the strongest arguments ever brought together in one paper in opposition to the system. He went to the bottom of the subject and brought out a great mass of evidence to show that in the so-called metric countries, where the metric system has been used for many years, there are numerous other systems in vogue, which, by the inertia or preference of human nature, or both, will probably continue to be used by individuals and firms for years to come. He explained fully, by apt illustrations, why the same thing would happen here were the metric system to be introduced.

The heavy artillery on the other side was handled with telling effect by F. J. Miller, of the *American Machinist*, Director Stratton, of the National Bureau of Weights and Measures, and J. H. Southard, chairman of the Congressional Committee of Weights and Measures, the latter two attending the meeting and speaking by special invitation. Many letters were read for and against the system, those from Cincinnati manufacturers in particular being strongly against it.



James M. Dodge.

The discussion comes up at this time, primarily because of the bill pending before Congress to require all the departments of the government to use the metric system, and to make the system the legal standard of the country (which, by the way, it is now, so far as the measures of length are concerned). The chief objection to the bill seems to be not so much the use of the metric system by the government departments as the fear that the government may wish to make the system compulsory, and might in any case require machinery or other products sold them to have metric dimensions. That the first of these effects would be possible or the second probable was vigorously denied by Chairman Southard and he is, perhaps, in a position to give as unbiased judgment as anyone. It was contended that it would be impossible for the government to compel the use of the system outside of its own departments, and that in selling machinery practically the same conditions would hold as in supplying the metric countries at the present time, where but few if any changes in the machines are required.

The committee previously appointed by the society to consider the metric system presented a report strongly advocating the English system, and denouncing the metric system. At the time of its appointment it was known that this committee was adverse to the metric system, and for this reason it was moved that the report be laid on the table and the motion was carried.

The council was then instructed by a very close vote to confer with other societies with regard to the appointment of a committee composed of members from each, to investigate the matter further. At a later session, also, the Secretary was instructed to prepare blanks to be sent to each member for obtaining his individual opinion regarding the system—a very happy ending of the whole controversy.

Abstracts of several of the technical papers presented at the different sessions have been prepared for use elsewhere in this number and in the next number of MACHINERY.

The New President.

The new President of the society, Mr. James M. Dodge, was born June 30, 1852, at Waverly, New Jersey, on the farm of his grandfather, Prof. James J. Mapes, a noted chemist and scientist of his day. His mother is Mrs. Mary Mapes Dodge, Editor of *St. Nicholas* Magazine, the leading children's magazine. After three years at Cornell University, and one year at Rutgers College, New Jersey, at which place he took a special course in chemistry under the late Prof. George H. Cook, geologist, he served an apprenticeship at the Morgan Iron Works, New York, and spent a number of years of his earlier life at the shipyards of John Roach, Chester, Pennsylvania. Afterwards he went to Chicago and entered the employ of the Ewart Manufacturing Company in the manufacture of link-belting, in which business he has been ever since. He is now president of the Link-Belt Engineering Company, the Dodge Coal Storage Company, the Stair Lift Company of Philadelphia, and a director in a number of concerns. He has taken out considerably over one hundred patents, a number of which have proved to be commercially valuable.

* * *

COOLING RAILWAY MOTORS BY COMPRESSED AIR.

Patents have been granted to Messrs. Mailloux and Gotshall for two systems of cooling electric railway motors by means of compressed air. The size of electric motors is seriously restricted by the gage of the wheels between which the motors must be located. The compressed air cooling scheme is designed to increase the power factor for a certain size of motor which means that it could run at higher speed and develop greater power without overheating. The maximum permissible working temperature for the motor coils, is from 150 to 160 degrees and if this is exceeded the insulation soon chars and becomes defective. The efficiency of the motor also decreases with the increase of temperature. The compressed air is conveyed to the motors by pipes from the airbrake system or an independent air supply. Three systems of controlling the air flow are suggested: Hand control, in which the exhaust from the airbrakes is diverted into the motor cases instead of being allowed to escape into the atmosphere; automatic devices set to discharge air into the cases periodically; and thermostatic devices that would open the air valves when a certain temperature had been exceeded. One great advantage of the system, aside from that of increasing the motor capacity, is that it allows of electric braking. Electric braking is desirable for two reasons, but in the present overworked state of electric railway motors, is not generally feasible on account of overheating; it returns to the line a percentage of the energy required to get a car up to speed, and partly eliminates the wear of brake shoes.

* * *

While it is undoubtedly the case that kerosene oil is of a very penetrating nature and that it will leak through a very narrow crack, it is also the case that water is nearly if not quite as penetrating. One reason that leakage of water through a narrow crack is not so apparent as that of kerosene oil, is that it evaporates and leaves little or no trace of the leak. Again if there is any sediment or suspended mineral matter carried by the water, the evaporation soon leaves a deposit that effectually seals the crack and prevents further leakage. In the case of kerosene oil the leakage does not evaporate, or does so very slowly, and spreads over the outside of the vessel making its presence very apparent whereas the total leakage may be quite small. With the oil there is no tendency for a leak to seal itself, but on the contrary kerosene oil is of a highly solvent nature, and tends to remove all deposits clogging the crack.

SEMI-ROTARY STEAM AND COMPRESSED AIR HAMMER LIFTER.

E. W. Merrill, Jr., Brooklyn, N. Y., has taken up the manufacture in this country of the Brett semi-rotary drop hammer lifter, of English design, which is here illustrated. These lifters can be operated either by steam or compressed air and can be used to deliver one or a series of equal blows, or they will deliver variable light and heavy blows. These blows are of an elastic nature as the return of the hammer is instantaneous. Fifty to seventy blows per minute are ordinarily given with these lifters while at a low fall as high as one hundred blows per minute can be obtained.

Fig. 1 shows an automatic self-contained drop with a 600 pound hammer. The two levers at the right are connected by light rods to the valves controlling the throttle and the automatic trip. The lever controlling the automatic trip moves between two quadrants containing a series of notches which hold it in any desired position. When in its highest, lowest, or intermediate notch, the hammer will trip, automatically, at its corresponding high, low, or intermediate fall. The change of fall can be made in a few seconds either with the machine in operation or at rest. The drop is operated by releasing the latch with the aid of the treadle in the same manner as on a board drop, one or a repeated number of blows being given until the foot is removed. The variable light and heavy blows are obtained by operating the throttle lever as on a steam hammer.

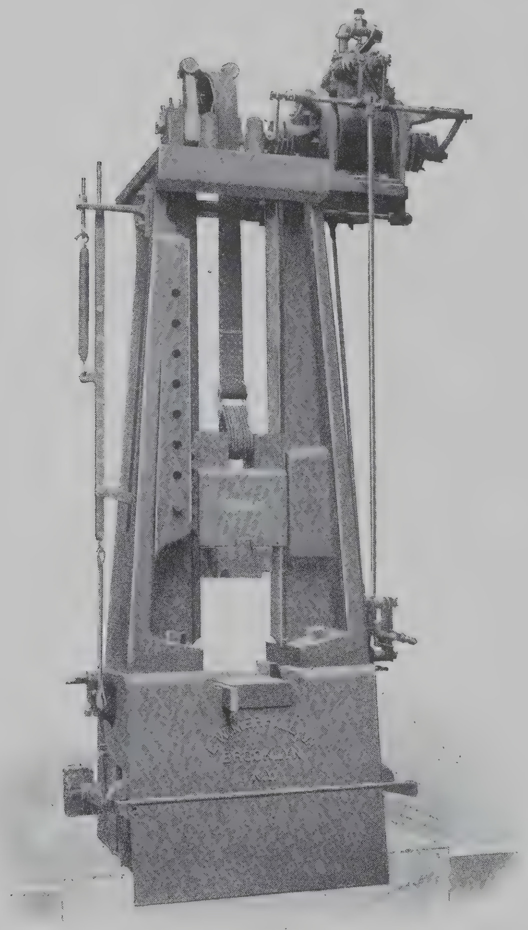
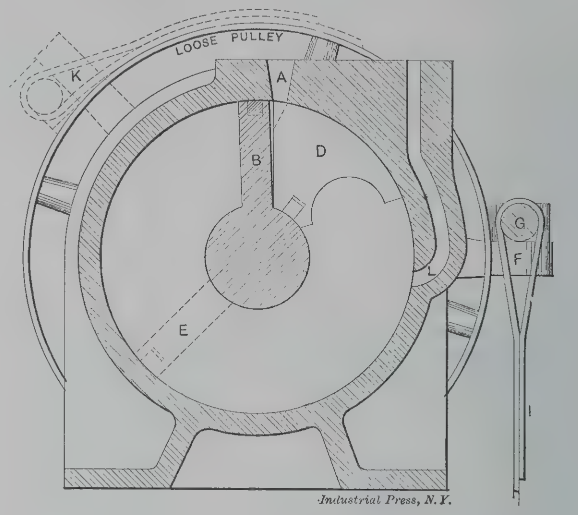


Fig. 1. Six hundred pound Drop Hammer with Merrill-Brett Hammer Lifter.

The method by which the hammer is raised will be clearly seen by reference to Fig. 2, which is a section through the cylinder with the piston, lifting arms and idler pulley in the positions which they would occupy when the hammer, which is fastened to the strap *I*, is down and at rest. In order to raise the hammer, steam enters the port A, presses against the wing B, and forces the piston to any desired position, say E. As the lifting arms F form a part of the piston shaft, when the piston revolves these arms are carried around to the position K carrying with them the strap *I*, and thus raising the hammer. When the piston has reached the position E, steam is cut off and that in the cylinder returns through the port A to the exhaust. This permits the piston to return to starting position and allows the hammer to fall. D is the division block and L the relief and safety vent.

This lifter may be applied to any style of drop hammer as the lifting mechanism can be mounted on any frame built over the hammer, or it may be located on the floor above. The scope of these machines is almost unlimited, drop forgings being now applied to all kinds of work. The size of work which can be handled in this way is constantly increasing, one case of recent practice being the forging, with these drop hammers, of mild steel locomotive pistons weighing 240 pounds each.



Industrial Press, N.Y.

Fig. 2. Section through Piston of Merrill-Brett Drop Hammer Lifter.

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COMBINED STANDARD AND OPEN-SIDE PLANER.

In many shops there is a demand for the occasional use of an open-side planer but not enough to warrant the purchase of a machine made exclusively for that class of work, and as a standard type of planer is much better for all-round work, the occasional open-side work is done with an extension tool with a great deal of trouble and expense. To supply this demand, the Mark Flather Planer Co., of Nashua, N. H., have designed and put upon the market, the combined standard and open-side planer, which is here illustrated. The cuts are made from photographs of their 42-inch standard planer changed to the open-side. As shown in the photos, the far housing can be moved back and an extension piece placed

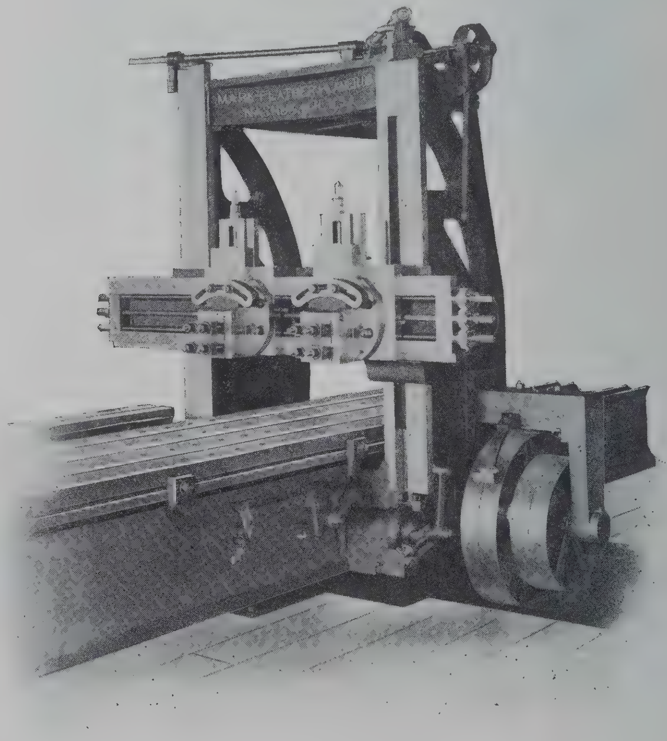


Fig. 1. Combined Planer arranged as Standard Machine.

between the cross-rail and the face of the housing. In the planer shown, the distance from the point of tool to face of housing is 63 inches, so that a piece 5 feet wide can be planed. The cross-rail, being the builder's regular standard 42-inch planer, with two heads on the rail, is long enough to square down work 63 inches wide with the far head, and by setting the head at an angle, several inches wider can be planed. A supplementary table to support the work, slides easily in a V-way, and gives a very secure outer support to which work can be bolted. A rolling table can be furnished instead of the above, if preferred.

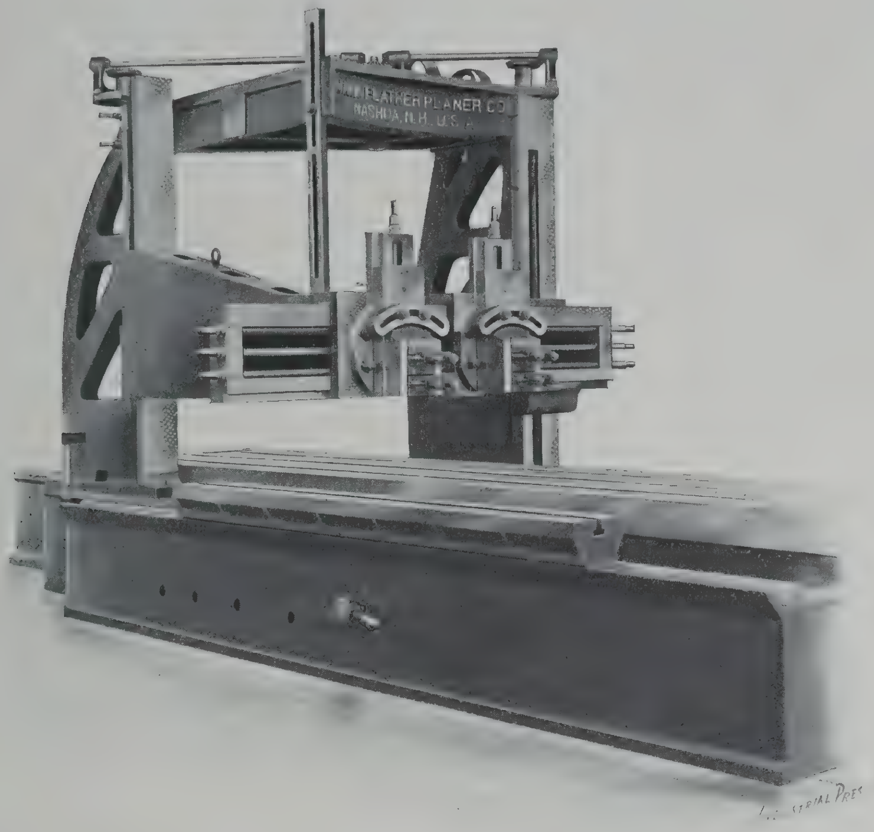


Fig. 2. Combined Planer arranged as an Open-side Planer.

The far housing is tongued into the top of bed, the cheek of which is made long enough to enable the housing to be moved back the required distance, with a rack pinion, so that the extension can be put into position and bolted to the cross-rail and housing, making a very rigid support for the rail. The face of the extension is made exactly like the face of the housing and is fastened to the rail by the same means as to the housing. The back part of the extension is made to fit over the two edges of the housing as well as to the face. The nut on the raising screw is disconnected from the rail and fastened to the extension and is made in such a way that the alignment of the rail is not changed by moving the housing. The rail is made to fit over the face and both edges of housings and is extended above and below the regular width of the cross-rail on the near housing, in order to give a greater bearing and support for the rail, so that when the far housing is removed, the rail will still be held rigidly in position. The change from a standard planer can be made in a very few minutes, and reversing mechanism can be operated from either side of the planer by hand and by the shipper dogs in front.

The power raising attachment for cross-rail, as shown in the drawing, is driven by two friction pulleys, similar to those used on countershafts for lathes. The bevel pinion on this shaft drives a double bevel gear in a central position on the tie which connects the two housings, the lower and larger one is driven by the pinion on the pulley shaft and the upper drives two cross shafts. One of these is rigidly connected with the near housing and the second one with the far housing and both are made to swivel round the central driving gear and also on the raising screw of the far housing. The shaft also telescopes through the bevel gear so that moving the housing from one position to another the shaft is free to slide through the gear as it moves around the circle of the central gear. As these gears revolve around the central gear, the relative positions of the raising screws are not altered since the bevel pinions revolve around the driving gear and also the bevel gear on the screw, consequently causing no change in the position of the screws. The driving gears are all contained inside the bed, which is double webbed around the gears and makes a stiff and powerful arrangement for driving the tables.

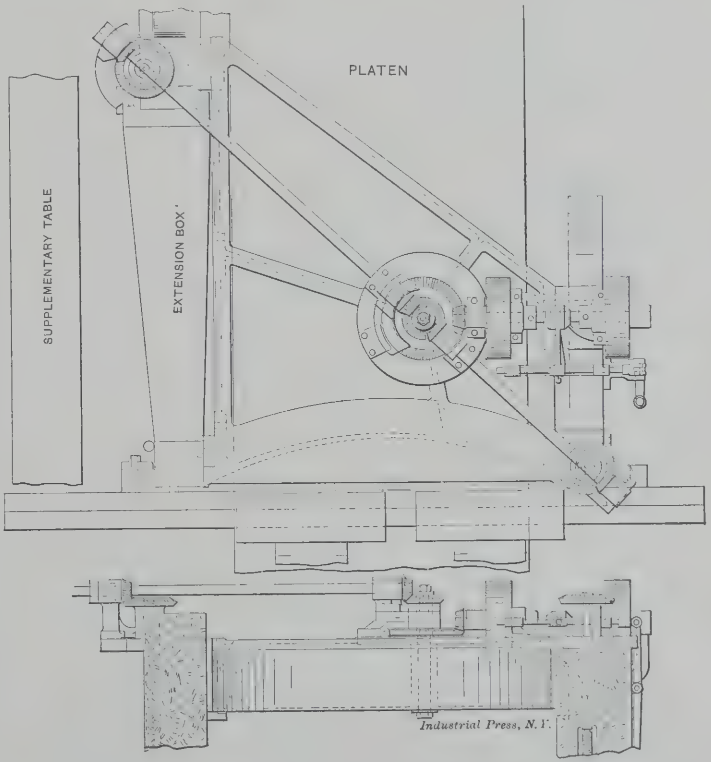
The feeding mechanism for the heads is driven by a new relief friction which has recently been brought out by the builders and is positive in its action in moving the feeds, but when released takes no power and does not heat. The reversing motion provides for one belt doing its work, then leaving the pulley before the other starts, preventing the disagreeable squealing of belts. The machine is entirely under the control of the operator at any part of the stroke and there is no unpleasant jar or jerk when the machine is reversed. In other features this machine is essentially the same as the standard planer built by this company.

* * *

Electrical traction has been found to be most satisfactory on the Manhattan Elevated Railway. The Second and Third Avenue lines are now completely equipped and 608 electric cars are in operation. It is expected that the Sixth and Ninth Avenue Lines will be completely equipped by April 1, 1903.

* * *

Brass is primarily an alloy of copper and zinc. Ordinary yellow brass consists of 2 parts copper to 1 of zinc. Lead is also used, a common mixture being copper 60, zinc 36, and lead 4. Bronze is an alloy of copper and tin. The standard ordnance bronze or gun metal, was formerly copper 90 and zinc 10, but the term "gun metal" is now a very elastic one. A gun metal alloy known as "steam metal" because of its common use for valves and fittings, is copper 87, tin 6, zinc 5, and lead 2.



Industrial Press, N.Y.

Fig. 3. Power Raising Attachment for Combined Planer.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

THE FIRST IRON BRIDGE.

After standing securely for upwards of 120 years the cast iron bridge which The Coalbrookdale Company erected over the Severn in the years 1777-1779 has failed by the sudden breaking of the girders. The structure is believed to be the first metallic bridge ever erected, and it possesses the further distinction of having given its name to the picturesquely situated riparian township of Ironbridge in Shropshire. The span of the arch is 100 feet, the width, exclusive of parapets, 26 feet, and the height from base-line to center, 40 feet, while the weight of iron in the bridge is about 380 tons. No details are at present available as to the cause of fracture, but it is surmised that "fatigue," due to long-continued vibration, may have some connection with the collapse. Cast iron for bridge building is no longer in favor, rolled iron or steel being the material generally used, but for all that, there are few wrought iron or steel structures now being erected that are likely to remain intact for such a prolonged period as has the famous cast iron bridge over the Severn.—*Ironmonger.*

FLOATING FIRE TRAPS.

The passenger steamers plying Long Island Sound are widely known as the most palatial inland-water boats afloat. The cabins and upper decks appear surprisingly spacious to one accustomed to the river or lake boats in other sections of the country. The upper works of the boats, however, while magnificent in appearance, are in reality mere tinder boxes, built with thin pine partitions. In the advent of a fire having a few minutes' start this inflammable material would be consumed in a much shorter time than it would take to tell the story. In 1888 the Fall River steamer *Bristol* burned while at the Newport wharf and although she was favorably located for fighting the fire and for the escape of the passengers, it was with the greatest difficulty that loss of life was prevented. Not profiting by this experience, the Fall River line has recently ordered another "floating palace," which, like its predecessors, will also be a floating fire trap. If it was impossible for the passengers and crew to escape from the comparatively slow-burning ocean-going steamers which were destroyed by fire at the Hoboken docks of the North German Lloyd line two years ago, how would it be in the case of a crowded Sound steamer a mile or two from land?

ANOTHER TOOL STEEL.

Another high-speed tool steel is said to have been produced by a new process at the Bismarck Furnace, in Silesia, Germany. The new material is claimed to greatly exceed in cutting power even the tool steel made by the Taylor-White process, and to have the added advantage that it will work successfully with much smaller cuts than the latter material. Thus it may be used on ordinary machine tools to increase their efficiency, whereas the Taylor-White steel can only develop its full efficiency on specially strong and powerful machines. This information is taken from the *Engineering News* which quotes the following from a German technical paper: "A certain steel shaft of hard steel (tensile strength 78,000 pounds per square inch) was given a cut of .024 inch with a feed of .12 inch. Using ordinary tool steel it took about 280 minutes to cover the surface of the shaft (about 775 square inches); with Taylor-White steel it took 140 minutes, whereas a tool made of the new material did the work in about one hour. It is stated that in working soft steel, with the new tool steel, taking a fine finishing cut, a peripheral velocity of 5½ feet per second could be reached, while other tool steels could not be made to cut at all at this speed."

FROM THE TECHNICAL SCHOOLS.

A short time ago we published an item regarding the new electrical laboratory of the Massachusetts Institute of Technology, Boston, which has been designed especially for research in the electrical field and has the equipment necessary for carrying on experiments similar to the advanced work conducted at the best German universities. These facilities for advanced study are now to be extended to other departments of the Institute, and beginning with the new year arrangements will be completed for several post-graduate courses, leading to the degree of Doctor of Engineering. To attain this degree students must be graduates of a technical school, or otherwise equipped for advanced work, and must carry on extended researches along original lines. They will be subjected to rigid examinations by the faculty, and in each case the degree will be conferred because of work completed rather than as an honorary degree frequently given to distinguished men by universities.

Another press dispatch of interest relative to educational matters is that several millions of dollars will be expended by the University of Chicago in establishing a technological department. It is expected that buildings for the new school will be begun next autumn and will cost, together with the equipment, at least $3,000,000.

ELECTRIC TRUCK FOR MACHINERY TRANSPORTATION.

In New York City the Niles-Bement-Pond Co. have taken the initiative among machinery dealers, by purchasing an electrically-driven truck built by the Vehicle Equipment Co., which concern is represented by the Rainier Co., 393 Broadway, New York. This truck is for use in New York city, and has a number of novel features. It has what is known as the pedestal running gear, the pedestal being a single steel casting fastened to the frame of the vehicle. The axle bearings are located in jaws in this pedestal and have absolute freedom vertically, but none laterally. The battery is below the wagon body, leaving the latter entirely clear, and is made of sectional trays which slide out at either side. The power is furnished by General Electric motors operating independently on the rear wheels. The tires are of 6-inch solid rubber. The controller has four speeds ahead and two for backing, and the battery has a radius of 25 miles on a single charge. The maximum speed of the truck is 5½ miles an hour. An electrical windlass is placed forward, under the seat, for loading freight, and is operated by an independent motor and controller.

A TEN-TON STEAM TRUCK.

This question of the use of motor trucks for the transportation either of raw materials or finished products is one that is being considered by many manufacturers. A few months ago we illustrated the details of the Morgan steam truck, manufactured by the Morgan Motor Co., of Worcester, Mass. Since then this company has brought out a 10-ton truck which is one of the most powerful automobiles ever constructed. It has a total length of over 22 feet and a width of 7 feet. A water-tube boiler is used, with burners using either fuel oil or kerosene. The engine is a double tandem compound, and the truck can always be started without reversing. Where unusual power is required live steam can be admitted to the low-pressure cylinders. There are two sets of driving gears, one in the ratio of 10 to 1, and the other of 20 to 1. The rear wheels, which do the driving, are fitted with steel tires, giving two inches of tire surface for every ton of load carried. The pulling strain of the engines is taken off from the rear springs by struts, which are braced against the supporting I-beams. The throttle is so made that when the lever is pulled back from the center, steam is admitted to the engine, but when the lever is thrown ahead of the center steam is admitted to a cylinder which actuates the brakes, and if for any reason they should fail to work the machine can be stopped by reversing the engine. On each end of an intermediate shaft connected with the engine is a capstan, and it is possible to throw the engine out of gear with the main transmission, so that it acts only on the shafts bearing these capstans. It is stated that by the use of these and of a hawser attached to a near-by tree or telegraph pole the machine can be pulled out of almost any difficulty and even backed down into the excavation and brought out again under its own power. There is also a crane on each side of the truck, by which the latter can be loaded or unloaded, heavy articles being picked up from the level of the ground. Another interesting feature planned by Mr. Morgan is to provide a truck with two or more bodies, which can be separated from the truck and loaded independently of it, thus saving the time usually lost in loading and unloading. The scheme would be to provide loading platforms in such a way that one truck body could be temporarily suspended for loading, while the truck backed against a second platform where the loaded body would be picked up and transported to its destination for unloading.

WIRELESS TELEGRAPHY.

As we go to press, dispatches announce the successful transmission of wireless messages by the Marconi system between the stations at Cape Breton, Canada, and Cornwall, England. While the transmission of these messages is apparently veiled in secrecy and may lead to some skepticism in the matter, there seems to be as good reason for believing the report as otherwise. In this connection the suits in this country now pending against the De Forest Wireless Telegraph Co., are of considerable interest, as the latter hold that Marconi is in no sense the inventor of wireless telegraphy. There have been a series of legal proceedings between the two companies. Among the claims of the De Forest Company is the one that the alleged inventions covered by Marconi patents were previously patented in England and the United States—the first being granted to Loomis as early as 1872, and one of the others in 1876 having been granted to Edison. It is also claimed that Marconi's patents were described in several papers in different countries before their date of issuance. By the De Forest system, messages can be sent at about the same speed as with any telegraphic system in which wires are used, 50 words a minute being possible; whereas it is said that 12 per minute is the greatest number that Marconi has succeeded in sending. However valuable the improvements in the De Forest system may be, we believe that Marconi will receive credit in the estimation of the public for persistently working upon wireless telegraphy until he succeeded in establishing its importance; and particularly since he himself does not claim complete originality, but admits that he has simply applied principles that have been understood by scientists for many years.

THE ECONOMY OF ELECTRIC TRANSMISSION.

In a paper, "Electricity in Railroad Shops," read before the November, 1902, meeting of the Central Railway Club, Mr. L. R. Pomeroy said that mere economy of power transmission by means of electricity as compared to other methods, is one of the least reasons for its adoption. The cost of fuel used to run the machinery of a manufacturing plant, is not usually over 3 per cent. of the cost of the article produced, labor and other items in which time is a factor representing about 47 per cent. and the material the remaining 50 per cent. But the obvious economy of electrical transmission is worthy of serious consideration. The friction load of line shafting remains constant, load or no load, while the transmission loss with electricity is always a percentage of the actual power used. If no power is being taken off by the machines, there is no transmission loss. The friction load of line shafting varies from 20 per cent. to 75 or 80 per cent. of the total power developed, and even more. It has been seriously stated that in a large cotton mill where the conditions were probably very unfavorable, as little as 1 per cent. of the power of the engine is applied to the cotton itself, the remaining 99 per cent. going into friction loss. The chief gain in machine shops, however, with electrical power transmission, is in the increased efficiency of the men and machines. In the matter of removing the wheels from a ten-wheel locomotive an electric crane will do in ten minutes what would require four men eight hours with common screw jacks, and four men one hour with pneumatic or hydraulic jacks. A list of 46 railroad shops was quoted in the paper, that have equipped with electricity or that are expected to do so in the near future.

SOLIDIFIED PETROLEUM FUEL.

A demonstration of the characteristics of a solidified petroleum fuel was given in Chicago recently, which apparently showed that the inventor, Mr. Austin Granville, has succeeded in overcoming the objectionable features that have hitherto accompanied solidified petroleum fuels made by other processes. The heat value of the briquettes is about 18,000 B. T. U. per pound, and they burn with a fierce white flame, leaving little or no ashes. The heat is so intense that for many purposes it is advisable to use coal dust, sawdust or other refuse of a carbonaceous nature to reduce the intensity of the flame. For steam making the preferable method of burning the briquettes is on a traveling chain grate, the air being admitted over the top and none through the grate. A plant having a capacity of 1,000 tons per day is being erected at Port Arthur, Texas, and another at San Raphael, California. The fuel can be delivered at tidewater from the Texas field at a cost of $1.20 per ton which, considering its greater calorific value, is equivalent to coal at about 90 cents per ton. The dangers attending crude oil in bulk are of so grave a nature that it is not probable that it can ever be used for many purposes where it would if the danger of fire was not so great. With the solidified product, however, the fire hazard disappears; also the difficulty of handling and transportation.

THE SUBMARINE BOAT.

A vast amount of money has been expended in this country upon the development of the submarine boat. From the time the United States *Housatonic* was destroyed by the Confederate submarine boat *David*, a great deal of attention has been paid to craft for navigating beneath the surface of the water, and, up to recently, the greatest progress has been made in France. But little public attention was drawn to the matter in this country until the creation of the first Holland submarine boat during the Spanish war. Mr. Holland has worked on the problem for many years and there is now a plant at New Suffolk, L. I., where there are several boats under construction for the United States Government. Recently experiments were conducted upon the two boats *Adder* and *Moccasin*, built at the above plant under the direction of a Government Board. The trials included a large number of runs—submerged, awash and floating on the surface of the water. The boats exceeded the contract speed, which called for seven knots per hour awash, eight knots per hour on the surface, and 5 knots submerged. For use when submerged there is an electric motor of 70 horse power, with storage batteries; while for running on the surface, gasoline engines are employed. The boat is fitted with tanks for compressed air, to provide fresh air for the crew; and a ventilating apparatus had to be devised, particularly since obnoxious gases are given out by the storage battery. The compressed air is also used for emptying water tanks when it is desired to shift the ballast. One of the chief difficulties in the operation of a submarine boat is its control in both vertical and horizontal planes. Apparently, these new boats can be as easily directed in one plane as in the other. It is generally admitted that the radius of action of submarine boats is not sufficient to enable them to operate at a great distance from the shore; but submarine propulsion has been so far improved that there is a good possibility of the submarine boat meeting with success in harbor and coast defense. It will at least have the effect of making an enemy uneasy.

DETERIORATION OF STEEL CAUSED BY "INTERNAL WEAR."

Iron and Machinery World. December, 1902, p. 19.

Charles H. Fitch in the course of an article on the deterioration of steel from internal wear, says that a boiler plate punch, especially a small punch, used to punch thick plates, soon loses its elastic strength. It may be as hard as ever it was, but some time it seems to break like glass. Now if we regard that bit of steel first and last as merely a hard solid body, the changes in that body will always remain blind mysteries. But if we recognize it in all its hardness and solidity as being what it is in fact—a collection of interwoven particles working together—then we can see how it is worn out by the interaction of these particles. This little punch which at the start will go through steel nearly as hard as itself, at the finish will break like glass because it is internally worn out. Though solid it is just as truly a spring as any spiral coil over a railway axle box. When it strikes the skin of the steel, which it pierces, it is driven back like a spring until the force of that spring's compression gives it power to drive through the steel. In going through a thick plate it may vibrate several times. It is in fact a spring battering ram, a little power machine. It has, therefore, the movement and friction of a power machine, and like a power machine it wears out. Then it breaks, not from some mysterious chemical re-formation of particles, not from anything like the crystallization which attends the passage of some bodies from the liquid to the solid state, but simply because it is internally worn out, and needs to be returned to the cupola or the melting pot to be made over from the inside.

MILLING CUTTERS WITH UNDERCUT TEETH.

Abstract from paper read by S. N. Brayshaw before the Manchester Association of Engineers, October 25, 1902.

A turning or planing tool for iron or steel has top rake, as well as clearance below, and milling cutters for many operations should have similar rake. A cutter, 3 inches diameter, 1¼ inch wide, with 10 teeth undercut 10 deg., was used on steel shafting in the works of L. Gardner & Sons, Ltd., the speed being 28 revolutions per minute, and the feed 1 inch per minute, with 9-16-inch depth of cut. This gives an approximate cutting speed of 27 feet per minute, and a feed of .036-inch per revolution. At this rate the cutter left a beautifully finished surface. It ran easily, and kept its edge well. It must not be assumed, however, that undercut teeth are necessarily advantageous. Frequently they are the reverse. Mr. E. G. Herbert, of Manchester, has recently made a series of tests with three cutters 6⅝ inches diameter, 9-32-inch thick, with 1 inch hole. In each case there were 30 teeth, which in one cutter were radial and in the other two were undercut 10 deg. and 15 deg. respectively. The cutters running at 20 revolutions per minute, or a cutting speed of 42 feet per minute, were fed separately into the vertical faces of heavy blocks, first of cast iron, and then of mild steel, until the machine stopped. The feeds varied from 1.4-inch per minute to .16 inch per minute, and there was no perceptible slip of the feed belt. The results of the tests were somewhat complicated, and the curves plotted therefrom were full of interest, but they failed to show any decided advantage of one tooth over another. The general indication seemed to be that the advantage rested with the undercut teeth with a big feed, and the radial teeth gave better results with a fine feed.

WELDING LOCOMOTIVE FRAMES IN SITU.

Railway and Engineering Review. December 6, 1902. P. 876.

Most practical railroad men are familiar with the process of straightening locomotive frames, *in situ*, that have been slightly bent by wrecks or other accidents, but there are few who would attempt to make a weld under such conditions. It appears, however, that where the use of liquid fuel is well understood, it is quite practicable to do this seemingly impossible job. A large number of broken locomotive frames have been welded in position at the West Oakland shops of the Southern Pacific Ry., 56 in all, and out of this number only five have since broken in the welds and this is attributed to the welds having been made at night when it was difficult to gage the heat. The first weld was made November 11, 1899, and the frame is still in service.

The plan followed is to strip the engine at the location of the break and to build up around the frame a temporary furnace of firebrick, after the plan usually followed when straightening bent frames. The furnace is built on a piece of sheet iron so that the whole affair can be quickly dropped into the pit when the welding heat has been reached. In practice, however, the first "setting up" blows are delivered before the furnace is torn down. Thus if the break is in a frame jaw, the lower end is driven up by a heavy pneumatic hammer weighing 30 or 40 pounds; if the break is in the top rail the tail piece is struck with a 1,000-pound ram a few times, with the furnace in place. Before the heat is taken it is the practice to jack the broken ends apart and to insert a piece of end-grain iron which is allowed to project all around about ¾ inch. This is, of course chipped off after the weld is made. The oil burner works under an air pressure of about 100 pounds. Kerosene, distillates or the lighter crude oils are found satisfactory fuels for this purpose. A 23 degree gravity crude oil is frequently used at the West Oakland shops with good success. It is stated that the adjustment of the burner as to the relative proportions of air and oil, is quite a delicate operation; also that the distance of the burner from the surface of the metal, the angle of the deflection and the location of the furnace bricks around the weld, are important. Considerable practice on the part of the smith is necessary to make satisfactory welds of this description, which is quite believable. It is recommended that preliminary experiments be made with bars of iron, iron axles, etc., before trying to weld a frame.

HEAVY STEAM PIPING.

New York Meeting Engine Builders' Association, Dec. 1-2, 1902.

At the last meeting of the Engine Builders' Association of the United States Mr. William Andrews read a paper upon "High-pressure Steam Piping," from which the following notes are taken:

"Up to the year 1900 the almost universal design for a piping system for power plants was to carry a pipe for each boiler into a large steam header, whose cross section was equal to the sum of all the areas of the feeding pipes. If the designing engineer wanted to be very grand he made it larger without knowing just why. From this header, pipes were carried to the various engines, of sizes called for by the engine builder. It was quite common to place steam separators in each line leading to an engine, but fashions change in steam piping, as well as in clothes, and with the advent of high-pressure and superheated steam, sizes of pipes have been very much reduced. In the four large power houses now built in New York city, with an ultimate capacity of from 60,000 to 100,000 horse power each, the largest steam mains are not over 20 inches in diameter, and these are used more as equalizing pipes or storage reservoirs. Some of our best plants have pipes which run from the header to the engine two sizes smaller than that called for by the engine builders. These pipes, before reaching the engine, are carried into a wrought-iron or steel receiver, which acts also as a separator. This receiver has a cubical capacity three times that of the high-pressure cylinder, and is placed as near as possible to the cylinder. The pipe from the receiver to the cylinder is of the full size called for by the engine builder. The object of this arrangement is, first to have a full supply of steam close to the throttle; second, to provide a cushion near the engine on which the blow caused by the cut-off in the steam chest may be spent, thereby preventing vibrations from being transmitted through the piping system, and, third, to produce a steady and rapid flow of steam in one direction only, by having a small pipe leading into the receiver. This steam flows rapidly enough to make good the loss caused during the first quarter of the stroke. Plants fitted up in this way are successfully running where the drop in steam pressure is not greater than 4 pounds, although the engines are 500 feet away from the boilers.

As to quality of material, in the earlier days of electric light and railroad plants, owing to the difficulty of keeping the screwed joints tight, some engineers tried flanged cast-iron pipe for steam mains, but it was heavy and clumsy and sometimes cracked on account of the unequal expansion. Then came copper, and this pipe, even when reinforced with steel wire wound around it, was found to be a treacherous metal. Flanged cast-steel pipe was tried, but the difficulty of obtaining this free from blow-holes barred it out. At present the material used is either wrought-steel or wrought-iron pipe, on which the flanges are either riveted, screwed or welded. In England and on the Continent they weld a light flange to the end of the pipe and face it; it is pulled together when in use by a heavy steel or cast-iron flange, which has previously been slipped over the pipe, very much as copper joints are made in marine piping.

In 1880 the New York Steam Co. installed about six miles of steam mains under the streets of the city of New York for power and heating purposes. All the joints in this pipe above 8 inches in diameter were made by expanding the pipe into recesses in the flanges, and then beading the ends of the pipe over the edges of the flanges. This was done by machinery, and was well done, and at the time was considered a great improvement over threading or riveting, but in five years every joint had to be taken out on account of leaks and threaded joints were substituted. These threaded joints lasted until 1895, when all the pipes were renewed with new mains having heavy wrought-steel flanges welded on the pipe. These welded flanges when turned true in the lathe make the most workmanlike and perfect steam joints in use at the present time, and their cost alone prevents their general use.

Corrugated-copper gaskets placed inside the bolts and well pulled up will make a joint which will last as long as the fittings. The softer gaskets containing rubber, asbestos, or lead alloys need constant attention, and when superheat is used they are rapidly destroyed. When the owner's bank account is strong enough ground joints without any gaskets are used. This makes a first-class job, but the price is all but prohibitive.

RESISTANCE OF AIR TO THE MOVEMENT OF FLYWHEELS.

Zeitschrift des Vereines Deutscher Ingenieure. 1902.

It has been ascertained by Herr Scholter, Manager of the Nuremberg-Further Trainways, that the resistance of flywheels is very far from being a negligible quantity. This resistance may be divided into two parts; that exerted by the friction of the air against the rim and that due to the displacement of the air by the arms; the latter being by far the more important of the two.

In the central station of the trainway there are two horizontal, tandem compound engines developing 450 horse power at a speed of 95 revolutions per minute. Each has a strong flywheel whose arms are formed of a double T with a central web set parallel to the center line of the shaft. The rotation of these flywheels produces a strong current of air which seemed to indicate the existence of a considerable resistance.

The suggestion was made to cover the two faces with a smooth protection of sheet metal, which was done. In order to determine the difference in the resistance under the two conditions, with and without the covering, one dynamo was made to serve as a motor to drive the unloaded engine. With the flywheel in its original condition, the work required was 13,300 watts, while, after the wheel was covered, only 9,874 watts were needed; a difference of 3,426 watts or about 5.7 horse power. The cost is then estimated, which may be reduced to American standards as follows:

Considering the engine to be running 17 hours per day for 365 days in the year on a consumption of 2 pounds of coal per horse power hour; the coal burned for the development of the power to overcome flywheel resistance will be about 35 tons, which at $2.00 per ton will be $70.00 per year. As the cost of covering the flywheels is an insignificant amount, the figures given above may be taken to represent a net annual saving.

As long ago as 1888 Prof. Brauer, of Darmstadt, called attention to the advisability of filling in the space between the arms of flywheels and cited an experiment made by Inglis on a 630 horse power engine in which indicator cards showed a saving of 30 horse power or 4.8 per cent. due to a reduction of flywheel resistances.—G. L. F.

FLYWHEEL EXPLOSIONS AND THEIR CAUSE.

Monthly Bulletin Fidelity and Casualty Co., December, 1902.

W. H. Boehm has received a letter from a cotton mill owner in which he says that his engineer has made a careful inspection of the flywheel driving his mill, and has reported that there are no defects or "buggers" in it. From this report the mill owner concludes that the wheel is safe and that danger from bursting is negligible. Mr. Boehm points out that flywheels do not often break from faults of construction or material, but from a sudden increase of speed due to some accident. Most flywheels that fail are really sound and safe under ordinary conditions. The fact that a defective wheel may run for years and then suddenly burst, shows that the immediate cause was not the defects, but some change from the normal condition under which the wheel had been running.

Wheels do not often fail from torsional stress or from twisting action in pulling their load, because enough material can be put in the wheel to resist successfully any load required of the engine. There is, however, no possible way to overcome the centrifugal force due to speed. Increasing the thickness of the rim of the wheel does not strengthen it so far as centrifugal force is concerned, because the weight added also increases the centrifugal force, leaving the wheel no stronger than before. There is, therefore, a definite speed at which any wheel, however sound, will explode, regardless of the amount of material it contains. For cast iron wheels sound theory borne out by good practice has fixed *a mile a minute* as the danger limit for the rim speed. Most wheels are run at or near this speed. The normal speed, however, is only of incidental consideration, as an accident may at any moment allow the speed to get beyond the normal. As the stress in the rim due to centrifugal force increases with the *square of the speed*, disruption quickly follows even a slight increase in speed. If the speed should be accidentally tripled, for example, the stress in the rim would become *nine times* as great as before, and the wheel would have exploded long before it had attained that speed. It is here that the "bugger" gets in his awful work.

In the case of the accident at the Amoskeag Cotton Mills, he got into the governor of the engine. Although he increased the speed only 20 per cent., the flywheel burst, wrecked the mill and killed two women and one man outright. In the case of the accident at the Griffin Manufacturing Co. a year ago, the "bugger" dropped a small washer in the port of the high-pressure cylinder, causing the slight increase in speed that precipitated a flywheel wreck in which the mill and an adjoining building were partially demolished.

As a matter of fact, the percentage of flywheels that explode is 33 per cent. greater than the percentage of boilers that explode, and the "bugger," by getting into the mechanism of the engine, is directly responsible for most of the trouble.

BRIQUETTING FINE ORES AND FLUE DUST.

Abstract from Paper read before the Engineers' Society of Western Pennsylvania, by Henry S. Mould.

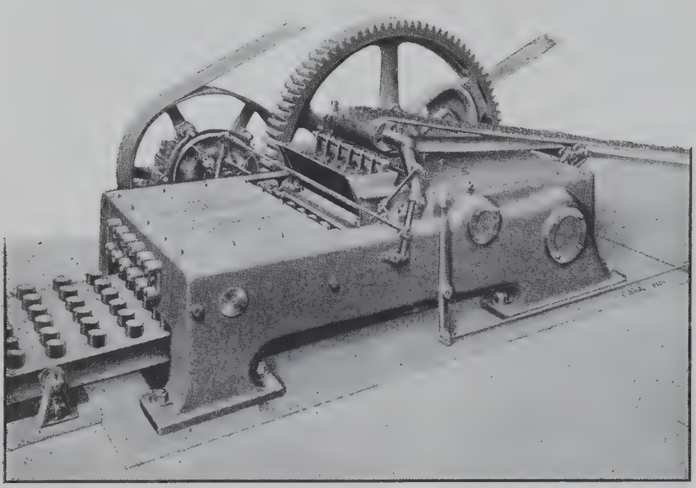
It is well known that in blast furnace operations metallic flue dust exists and that on this account there is a large loss to furnace owners. The scarcity and value of lump ore and the consequent necessity for using large quantities of fine material in the furnace increase the flue dust loss and give rise to other dangers and evils that sometimes entail heavy property loss and even the loss of human life.

It is to do away with these evils that briquetting this fine material has been resorted to, and progress has been made only through a long succession of failures, owing mainly to the difficulty in constructing suitable machinery, and the high cost of the bond. Conditions vary widely in different regions and with the materials that are to be put into block form. The bonding agent that can be successfully used with precious metal concentrates or flue dust from the smelters cannot be successfully used with anthracite culm, and the binder used in briquetting the latter cannot be used in briquetting iron flue dust or fine ores. Adjustability of pressure is also essential, as different materials require varying pressure, ranging from 2,000 to 18,000 pounds to the square inch.

About 1895 the most available machine for briquetting was what is known as an "eggette" machine, which is composed of two large rolls, each having an indentation in its face similar in shape to half an egg, so placed as to register accurately and so designed as to allow the eggette thus formed to drop onto a conveyor or belt. While the briquettes manufactured by this process were strong enough to stand up in the furnace, there were a number of other difficulties that made further experiment necessary before a successful process could be evolved. In the first place, using the "eggette" type of press, so large a percentage of binder was necessary that the cost of briquettes was too high. In addition to this, the machine as then constructed would not stand the wear essential in that class of work.

One of the more successful of the earlier machines was the White mineral press. This was of the disk type, the briquettes being formed in 48 molds, all in one piece known as the disk. It was found, however, that the briquettes were not hard enough to stand the pressure in the furnace without first drying; that special auxiliary machinery was required and that the cost for repairs was excessive. The gritty nature of the flue dust acted as coarse sand-paper or emery on the molds and necessitated the frequent purchase of new disks. The disks could not be re-ground or renewed; it took three men nearly half a day to replace one; a new disk weighed 1,500 pounds, was five feet in diameter, and cost about $150. This heavy repair cost feature had to be eliminated.

The second machine, patented in 1898, which was believed would do away with the faults shown by the mineral press, was an entirely new type. Instead of a disk arrangement to carry the molds to the point where the pressure was exerted, there were six molds placed in a reciprocating press-box, into which spring and compression plungers were thrust, capable of exerting enormous pressure. These molds are simple in design and can be removed and replaced at a nominal cost. As they sustained all of the wear, this did away with the enormous repair cost essential where an expensive disk was used.



No. 1. White Briquetting Press, Capacity 100 tons in ten hours.

A testing plant was fitted up, one of the plunger type presses was installed there and the experimenting went on for three years. Binder after binder was tested and careful records of each experiment were kept. During this time, the process of briquetting in a number of fields was perfected but the successful handling of iron flue dust was still beyond the grasp of the experimenters.

A little over a year ago another testing plant was fitted up, complete in every detail, with heating and drying apparatus so as to show the process of briquetting any fine material. The plunger press had been improved in many small details, although the principle of the machine remained the same. At last a binder was discovered that would hold iron flue dust, iron concentrates, or fine iron ores in hard and satisfactory briquettes, but it took 12 hours to dry them. After a little more experiment and investigation the point was reached where a binder and drying apparatus were perfected that gave a continuous process for the briquettes from the flue dust bins to the finished briquette in cars or storage bins, the whole operation taking approximately half an hour, and these are now used in the so-called Mould process.

In attempting to briquette the flue dust it was found that the solution of the problem was much more difficult than that of the handling of fines at precious metal smelting works. One main reason was the fact that the tiny particles of iron flue dust as they are whirled about by the blast are rounded until each particle, when seen through the microscope, appears as round as a marble. In addition to this, each little piece of ore is covered with a greasy carbon coating which seems to counteract the effect of a binder. For these reasons, it has been difficult to find a binder that would give a briquette with all the essential conditions. The difficulties may perhaps be better realized when it is known that the requirements call for a briquette that shall be hard and durable; waterproof; low in moisture; able to stand long transportation in open cars; not unduly refractory or liable to decrepitate or become dust again; and the binding agent must not injure either the lining of the furnace or the quality of the iron produced.

Many striking illustrations of the possibilities of briquetting processes can be derived from the statistics of ore production. In a blast furnace producing 600 tons of iron a day, the furnace burden approximates 540 tons of coke, 375 tons of limestone, and 1,085 tons of ore; a total of approximately 2,000 tons. Assuming that the furnace managers use 80 per cent. of Mesabi ore, or 868 tons, and lose 8 per cent. of the Mesabi burden in flue dust (and these are under the actual figures if anything) what does this mean in dollars and cents? It means that every 24 hours the furnace owners are absolutely throwing away 70 tons of ore. Estimating the value of Mesabi ore in Pittsburg at $3.50 per ton, this means that the loss in flue dust alone is $245 per day or $89,425 per year.

And this is not all. There are even greater things that can be accomplished by briquetting. In 1901 the total shipment of ore from the Lake Superior region was 20,589,237 tons, and of this the Pittsburg district received about 11,000,000 tons, of which about 44 per cent., or 4,840,000 tons came from the Mesabi range alone. Exact and careful analysis of ore cargoes, however, shows that the ores carry a heavy percentage of moisture. In 1901, from a tabulated list of these analyses compiled by the ore agents of the big steel companies, it was determined that the average amount of moisture in the Mesabi output from 52 mines for the year was 10.57 per cent. In other words, the manufacturers of iron and steel in the Pittsburg district are hauling from Lake Superior, and paying freight on 511,588 tons of water. The freight rate from the Mesabi range to Pittsburg is $2.35 a ton. On this basis, Pittsburg manufacturers are paying $1,202,231 a year for hauling water from the mines. With the use of briquetting machinery, this waste in freight can be saved to the manufacturers. It is quite possible to briquette the fine ores at the mines. After first drying the material by driving off the moisture and then pressing the fine ore into blocks, the raw material can be brought direct to the furnaces in this district as lump ore, in briquettes that are waterproof and that are abundantly able to withstand the rough usage inevitable in transportation. By this means all of the evils that must now be contended with, arising from the use of fine ores, can be absolutely done away with.

CONTINUOUS CURRENT MOTORS FOR MACHINE TOOLS.

Abstract from Paper read by F. O. Blackwell before the American Institute of Electrical Engineers. November 21, 1902.

Planers, slotters, milling cutters and many other tools need only a slight variation in speed, as the relation between the tool and its work is always the same, variation in speed only being required for different classes of work—that is, for hard or soft metal or for a roughing or a finishing cut. Such work does not require more than a 2 to 1 variation, while on the other hand, lathes, boring mills and other rotating tools may require an 8 to 10 or even 40 to 1 variation, necessitated by the varying diameters of the work. For instance, take a lathe in which is being turned a shaft six inches in diameter, to obtain a cutting speed of 50 feet per minute, it will require approximately 32 revolutions per minute of the main spindle, while if the flange of a 48-inch wheel was being turned, it would require only four revolutions per minute of the spindle to obtain the same cutting speed.

The common method in use for attaining variable speed by means of the electric drive, are rheostatic, field and multiple voltage control.

Rheostatic control is obtained by introducing resistance in series with the armature of an electric motor, the speed being reduced in proportion to the power consumed in the resistance. Therefore, if a constant horse power is desired at the tool, a motor when running at reduced speeds receives a reduced potential and requires an increased current. For example: If a motor is running at one-half its normal speed it receives but one-half the line potential and requires double current. From this it will be seen that as the rheostat is consuming practically one-half the power applied, the efficiency of the combination is less than 50 per cent. This method of control is undesirable, not only on account of its being very inefficient, but also from the fact that as the load decreases the speed increases; and should a man be working on a piece of material where the cut takes only part of a revolution, the speed will immediately increase, as the tool leaves the work, to such an extent that in all probability the tool will be burned or perhaps broken when it enters the work again.

By varying the current flowing in the field coils of the motor the strength of the magnetic field is changed, and the speed of the motor varied. With any setting of the field, however, the motor will give constant speed under changes of load, and this method therefore avoids the greatest objection of rheostatic control. A motor of ordinary design will not always permit of any considerable weakening of the field without sparking at the commutator; but with a motor having small armature reaction a variation in speed of 2 to 1, can readily be obtained, and when delivering a constant horse power the current will be approximately the same at all speeds, because the potential across the armature terminals is always the same. As the field current of a motor is only a small fraction of the total current, the efficiency of this method of control is practically the same at minimum and maximum speeds; it also allows the use of a much smaller controller and renders it possible to get a greater number of running speeds than can be economically arranged for with any other control.

Multiple-voltage control is obtained by having several different line potentials to work from. For instance, with the Edison three-wire system the potential from the neutral to the outside wires is one-half the potential between the outside wires. There are, therefore, two potentials available, and a motor connected between the neutral and one outside wire would run at one-half the speed it would when connected across the outside wires. A four-wire system may also be used in the same manner, giving various combinations of potentials, the minimum of which may be about one-fourth or one-sixth of the maximum potential.

Either of the above methods combined with the field control of the motor makes a very flexible system. For example, a motor having 100 per cent. field control used on the three-wire system will give a speed variation of 4 to 1, or a motor having 35 per cent. field control used on a four-wire system with potentials of 60, 80, 110, 140, 190 and 250 volts will give a speed variation of approximately 6 to 1, or with potentials of 40, 80, 130, 170, 210 and 250 an 8 to 1 speed variation, the gaps in speed between the various potentials being filled in by field control of the motor.

It has been demonstrated many times that it takes practically a constant horse power to remove a given amount of metal per minute, irrespective of the rotative speed of the tool. Therefore, the main spindle of a lathe taking a ⅜-inch cut on a 6-inch steel shaft with a feed of ⅛-inch and a cutting speed of fifty feet per minute makes 32 revolutions per minute, and takes a certain horse power to drive which we will assume to be 15 horse power, and the motor will be working on its highest potential or 250 volts. Now, if we are using the multi-voltage system with the last-named potentials above, and should put a 48-inch wheel in this same lathe and turn up its rim with the same cut, feed and cutting speed, the main spindle would run at about four revolutions per minute or one-eighth of the previous speed, but still require 15 horse power to drive. With this condition the driving motor would have to run on its lowest potential or 40 volts, and would be consuming fully six times the amount of current it did previously. A motor to be used on the multi-voltage system will have to be sufficiently large to carry its maximum horse power at the minimum potential, or, in other words, at, say, 40 volts on a 250-voltage system, the motor will have to be six times too large when working on its maximum potential. For this reason it is desirable that we keep the lowest potential employed as high as possible in order that the size and cost of the motor may be within reasonable limits. A potential of 40 or 60 volts requires such large conductors, if they are laid out for a small drop, that their cost is prohibitive in a plant of any size. If a large drop is used, the motor falls off in speed under load and its speed regulation under changes of load is little better than with the rheostatic control.

With the three-wire system and a 100 per cent. variation in the motor speed by field control, we can obtain a 4 to 1 total variation which, for general machine-shop work, is sufficient to cover a single operation on a given tool. The total range, however, on a tool can be increased greatly by having a few gear changes. For example, on a back-geared lathe with a gear ratio of 4 to 1 a total variation of 16 to 1 can be obtained. In the same manner on a double-geared lathe a variation of 64 to 1 might be obtained.

The reduction effected by different sets of back-gears on machine tools will be found to vary from 4 to 1 to 6 to 1. All tools can be arranged with 4 to 1 changes between back-gears without any difficulty. In many cases a single back-gear is sufficient for a tool. By putting a magnetic clutch on this back-gear and making the electrical connections in the controller, it is possible to get a 16 to 1 variation electrically and without increasing the cost of the motor more than would be required for a 4 to 1 variation.

With electrical control a man can keep his hand on the controller and his eyes on the tool, increasing the speed from time to time. Being limited only by the temperature of the tool, it has been found that much higher cutting speeds are unconsciously attained with a motor-driven tool than would be thought possible were any fixed rule followed. It is therefore apparent that this increased production in many cases is so great as to fully justify the installation of an electric system, even if there were no other advantages to be secured.

In conclusion, the author gave it as his opinion that it will generally be found best to use motors with field control, allowing a total speed variation of 2 to 1 with the two-wire system or 4 to 1 with the three-wire system, believing that the four-wire system is too expensive for general application if the plants employing it are properly designed and equipped with large enough electrical apparatus. For reciprocating tools a two-wire system will meet all requirements, and there are very few rotating tools where it is not better to mechanically vary the speed for all speed variations greater than 4 to 1.

The most important consideration in the electric driving of machine tools is to make the control of the tool as convenient as possible and arrange the system so as to permit small changes in speed, and consequently be able to always drive the tool at its highest possible speed and greatest output.

NEW OIL TESTING MACHINE AND SOME OF ITS RESULTS.

Abstract of paper read at the Annual Meeting of the A. S. M. E.

In this paper Mr. Albert Kingsbury describes a machine built by him for the purpose of making comparative tests of various kinds and grades of oils. There are two important properties in lubricating oils and greases on which their value depends—viscosity and body. Viscosity is the property by virtue of which the lubricants form comparatively thick films between rubbing surfaces, permitting perfect lubrication. The effect of the lubricant in reducing friction depends mainly upon the "body" or "oiliness."

The nature of this property, or combination of properties, is not well understood, but it appears probable that it is an intensified viscosity in that part of the fluid within the region of attraction of the surface molecules of the metal.

Experiments have shown that the effects of body and of viscosity are in nearly all respects diametrically opposite, and that it must necessarily be very difficult to derive reliable information regarding the lubricating values of oils from friction tests in which the effects of viscosity and those of body are not separately recognizable. Under this consideration, methods of testing which are described in this paper are arranged with special reference to the conditions under which the effects of either property may be investigated independently of the effects of the other.

In the machine with which these tests were made, the test journal has its axis vertical; it is suspended from the spindle by means of a flexible coupling and runs between two opposed bearings in a cylindrical cup or case, which may be filled with the oil to be tested if a "bath" is desired. The load on the bearings is provided, by means of a helical spring of 900 pounds capacity, with screw adjustment and with a device for quick application or removal of the load without disturbing the adjustment. In testing, the suspended parts turn freely to a position where the torsion of the suspension wire balances the friction at the test journal; and the angle of torsion, which may be as great as 270 degrees, is read from a graduated disk. The cup and the test journal contained in it may be heated as desired by a Bunsen flame. The revolutions of the journal are indicated by a counting device.

For tests involving perfect lubrication (friction due to viscosity only), the test journal used is 1⅜ inches in diameter, of tool steel, hardened, ground and polished. The brasses are sectors cut from a ring finished in the lathe, each having an arc of about 120 degrees and a length of 2 inches.

A number of curves have been plotted from tests made with this machine which seem to verify the deduction that the friction is proportional to the viscosity of the oil, and they also show the friction to vary roughly as the square root of the speed.

For tests for comparing oils with respect to body or oiliness the best results have been obtained by the use of a hardened and polished steel journal ¼ inch in diameter, running between two brass bearings about 1 inch long; on this small journal pressures up to 8,000 pounds per square inch may be applied if necessary. In making these tests the oil giving the less friction is assumed to have the greater body. The writer has not found the order of body values, as determined by this method, to vary with the speed or the pressure within a considerable range. A speed of 50 to 100 revolutions (3 to 6 feet per minute), with sufficient pressure to make the coefficient of friction only as great as .01 to .03, have been found most satisfactory; the pressures being from 500 to 5,000 pounds per square inch, according to the character of the oils.

The results of this method of testing for body agree thoroughly with the principal fact hitherto established with regard to body as distinguished from viscosity—namely, that the mineral oils as a class have much less body than the animal and vegetable oils. For example, in a body test of the mineral oil and the lard oil having viscosities 98.9 and 83.7 respectively, as determined by the Dudley pipette, the lard oil, although the less viscous, gives very decided evidence of greater body, by its much smaller friction. On the other hand, certain cylinder oils, wholly or largely mineral, and greatly exceeding lard oil in viscosity have also greater body than lard oil.

FLYWHEEL CAPACITY FOR ENGINE-DRIVEN ALTERNATORS.

Abstract of paper read at the Annual Meeting of the A. S. M. E.

Mr. Walter I. Slichter presented a paper which was written with the object of showing certain considerations which must be borne in mind when selecting a steam engine to drive an alternating current generator which is to run in multiple with another generator or which is to generate power for a system in which synchronous apparatus such as synchronous motors or rotary converters are to operate.

In a comprehensive manner he discussed the mechanical action of the engine when direct connected to the alternating current generator and also the allowable fluctuations in speed. A displacement of phase in the electric current of 2½ degrees from the mean will cause a cross current of about 10 per cent. of full load current to flow. This value has been more or less generally adopted by the builders of electrical machinery as the limit of displacement, if satisfactory running is to be expected. To determine a weight of flywheel which would limit the displacement to a value approximately equal to 2½ degrees the following formula has been determined, based on the unbalancing factors with a reasonable increase to allow for overloads:

$$W r^2 = \frac{K W \times C \times 10^9}{S^4}$$

where W = effective weight of wheel, KW = rating of generator, S = speed of engine in R. P. M., r = radius of gyration, C = a constant as follows:

	Horizontal Single-crank.	Vertical Cross-compound.	Horizontal Cross-compound.
25 cycles	315	275	250
40 "	505	440	400
50 "	630	550	500
60 "	755	660	600
125 "	1575	1380	1250

While not always giving the most desirable flywheel capacity, since it would be impossible to take into account all the irregularities of some engines, yet it gives a value suited to the various conditions (such as frequency of alternator, style of engine, etc.), such that if the engine is reasonably good we will get the results desired. If this weight of flywheel does not give satisfactory results it would be much better (for the electrical circuit) to make such changes in the engine itself as to give a better crank effort diagram than to increase the weight of flywheel, for a flywheel may easily give trouble by being too heavy.

As changes in the engine, the following are suggested:

First, as best though most difficult, changing the angle between the two cranks.

Second, changing the proportion of load taken by the different cylinders, and make the low pressure take more load.

Third, introduce compression at the end of the stroke to take up inertia, particularly in low-pressure cylinder.

* * *

TWO NOTABLE SPECIAL NUMBERS.

The November 6th issue of the *American Machinist* and the November issue of *Cassier's Magazine*, are notable examples of the special number scheme in trade journalism. The *American Machinist* special number was issued in commemoration of its twenty-fifth anniversary and is, of course, largely given over to an interesting historical review of mechanical progress that has taken place during its lifetime. The leading articles were contributed by men who have become eminent in various branches of engineering.

The November issue of *Cassier's Magazine* is a machine shop number, being entirely devoted to articles on various phases of this subject. There are 272 pages of reading matter and illustrations, and about 200 pages of advertising. Among the articles we note: The Multiplication of Cutting Tools by Joseph Horner, Electric Power in the Machine Shop by W. M. McFarland, Portable Machine Tools by Forrest R. Jones, Limit Gages in the Machine Shop by Wm. H. Booth, etc. It is needless for us to say that both of these special numbers are of great interest and worthy of the attention of every progressive mechanic.

A writer in the *Foundry* says that an alloy discovered by accident, which resists the action of strong sulphuric and hydrochloric acids, hot or cold, and which is only partially dissolved by hot nitric acid, has the following composition: Lead, 66.89; copper, 11.32; tin, 10.52; antimony, 3.70; iron, 0.75; silicon, 2.09, and sulphur, 0.53. We assume that parts and not percentages, are meant since the sum total is not 100. In general it seems best to give such formulas in percentages since typographical and copying errors in the figures may then be readily discovered.

* * *

In the notice given in the December issue of the death of Frederick Alfred Krupp, an obvious error was made in the statement of building property area covered by the Krupp Works in 1890. Instead of 11,700 acres, it should have been 117 acres.

PINS AND PIN MACHINES.

EXTRACT FROM UNITED STATES CENSUS REPORT, 1900.

The invention of the process of wire drawing marked the beginning of the modern pin manufacture. The process originated in France and Germany, and for two centuries these countries monopolized all industries dependent upon it. The first man to manufacture brass pins in England was John Tilsby, who, in 1626, established a plant in Gloucestershire, where he met with remarkable success, and his make of pins became famous. By 1636 the industry was so well established that the pin makers of London formed a corporation, and the trade soon found its way to Bristol and Birmingham, where, in connection with other ironwork manufacture, the industry became localized. In those cities pins were made for some time by hand labor. About 1800 William Bundy invented a method of heading pins which was the modern process in embryo.

In 1812 Bradbury and Weaver conceived the idea of heading "by means of an automatic machine." After the shanks were pointed and the heads prepared they were put into separate hoppers, where a mechanical device placed the shank and head into relation with each other. In this position the pins were pressed by screws against dies, which made the head and bound it to the shank, when they were withdrawn by hooks operated upon by parallels worked by the machine.

In 1817 Seth Hunt invented a machine to make the pin with head, shaft, and point from one piece, but his invention was not a success. In 1824 W. L. Wright, an American, a native of New Hampshire, invented the solid-headed pin-making machine, which entirely revolutionized the pin manufacture. He did not have his machine patented in America, but took it to England and put it into operation. He formed in London a company with a large capital, and built a good-sized factory in Lambeth. A plant was fitted up at great expense with 60 machines, but they were never put into successful operation, as they failed in pointing the pin. Although Wright remedied this defect by a supplemental machine, the company did not succeed, and suspended operations with a great loss to those interested in the enterprise. Fortunately, in the readjustment of the company's affairs the machinery fell into the hands of D. F. Taylor, who, by interesting capitalists in the enterprise, brought about the formation of a company known as D. F. Taylor & Co., which in 1833 put upon the market the first machine-made solid-headed pins sold anywhere in the world.

As early as 1812 the inventors of this country were using their energies to construct a machine for the manufacture of pins. The first machine made here, which was brought out by Moses L. Morse, of Boston, Mass., some time during the war of 1812, proved too delicate and intricate to be used to much advantage and was soon abandoned. The man who did more than any other individual to place the manufacture of pins by automatic machinery on a practical and successful basis in this country was Dr. J. I. Howe. In 1830 he began his labor in this direction, spending some of his time in Europe studying the methods employed there, and by the year 1832 he had patented in this country, France, and England, a machine designed to make pins similar to the English diamond pins, with heads formed of coils of small wire fastened upon the shank by pressure between dies. He brought the business to a successful issue in 1836, when the Howe Manufacturing Company was formed in New York and began operations at Birmingham, Conn. At first automatic spun-head machines were used, but in 1840 they were converted into solid-headed machines. These latter machines at first made from 40 to 50 pins per minute. They were later improved so that they made from 60 to 70 per minute.

About 1835 Samuel Slocum, an American, obtained a patent in England for a machine to make solid-headed pins. In 1838 he began with this machine the manufacture of pins in Poughkeepsie, N. Y. As he never had the machine patented here, it was operated secretly for a number of years. Until 1842 the industry made little progress because of discriminating tariffs. In this year, however, a new tariff law went into effect which was more favorable to this industry than the previous tariff act, and the above-named companies did a very profitable business. Led by exaggerated ideas which became prevalent as to the extent of the business and the profit made in it, many persons in different parts of the country invented machinery for the construction of pins. Attempts in this direction met with varying success but the articles turned out were, with a few exceptions, inferior, and the market became overstocked. In consequence of this over-production, by 1848 all parties engaged in pin making, except the two old companies at Poughkeepsie and Birmingham, suspended operation. In the year 1850 there were four establishments engaged in this industry, and the success attending them led to further improvements in the machines. A Mr. Fowler and a Mr. Atwood perfected machines to make 160 to 170 pins a minute which, on account of their capacity, soon replaced the early machines.

Following the successful introduction of a machine for making the pins, the next important step was to invent a machine that would stick them on paper. Howe and Slocum gave their attention to this matter as early as 1840. Dr. Howe invented the device for crimping the paper, and this was followed by the distributer of Mr. Slocum. The two inventions were combined and effected a great increase in the number of pins that could be stuck on a paper in a day. These devices were improved upon by Mr. De Grasse Fowler, who invented the "goose neck" or "runway." For many years the sticking machines consisted of a combination of these three devices, but more recently machines of various styles have come into use that will stick from 500 to 600 packages a day, far more than the early combined machine of Howe, Slocum, and Fowler.

The old process of pin manufacture by manual labor was very slow and tedious, since each pin passed through the hands of from 14 to 18 individuals. The modern pin is made in the United States by the improved Atwood or Fowler machines. The process of pin manufacture by modern machines may be briefly described as follows: Coils of wire are placed upon a reel, whence the wire is drawn automatically by a pair of pincers between fixed studs that straighten it. A pin length is then seized by a pair of lateral jaws, from which a portion of the wire is left projecting, when a snaphead die advances and partially shapes the head. The blank is then released and pushed forward about one-twentieth of an inch, when the head is given another squeeze by the same die. By this repetition of the motion the head is completed and the blank is cut off the wire in the length desired. About one-eighth of an inch of wire is required to make a pin head. If the attempt were made to upset this with a head in one motion the wire would be more likely to double up than to thicken as desired.

The headed blanks then drop into a receptacle and arrange themselves in the line of a slot formed by two inclined and bevel-edged bars. The opening between the bars is just large enough to permit the shank of the pin to fall through, so that the pins are suspended in a row along the slot. When the blanks reach the lower end of the inclined bar in their suspended position they are seized between two parts of the machine and passed along, rotating as they move, in front of a cylindrical cutter, with sharp grooves on its surface, that points the pins. They are then thrown from the machine properly shaped, and if they are brass pins they are cleaned by being boiled in weak, sour beer. After they are cleaned they are coated with tin. This is done by placing alternate layers of pins and grain tin in a copper can and adding water, along with some bitartrate of potash. Heat applied to this produces a solution of tin which is deposited on the surface of the pins. The pins are then taken from this solution and brightened by being shaken in a revolving barrel of bran or sawdust. Lastly the operation of "papering" takes place. This process is performed now by an automatic papering machine something in the following manner: The pins to be stuck are placed in a hopper, in connection with which a steel plate is used, with longitudinal slits corresponding to the number of pins which form a row in the paper. The pins in the hopper are stirred up by a comb-like tool, the shanks drop through the slits in the steel plate, and the pins are suspended by their heads. Long narrow sheets of paper are presented by the operator to the action of the machine, by which two raised folds are crimped, and the row of pins collected in the slit steel plate is then, by being subjected to the same action, pressed through the two crimped folds. These operations are repeated until the requisite rows of pins are stuck in each paper.

LETTERS UPON PRACTICAL SUBJECTS.

A SUGGESTION TO THE APPRENTICE.

Editor MACHINERY:

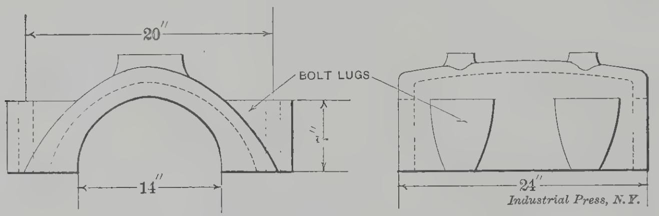
I wish to make a simple suggestion to the apprentice, which, if followed, will be sure to be appreciated in after years. It is an almost daily occurrence to hear old journeymen, during the noon hour, discussing their various tools, where they were purchased and what they paid for them. During one of these discussions one of the men was noticed to be the center of interest among his shop mates. He had traveled over the United States and the Old Country quite extensively and one of the men asked him some questions concerning some of the places which he had visited. He took from his tool chest a small note book which contained notes from the time that he started to learn his trade, each place in which he had worked, the name of the firm, location, superintendent, general foreman, etc. Also the date of entering and leaving the place, the wages received, tools purchased, where, when, and their cost. It was interesting to see the men gather around him and ask him to read some of the notes from this book.

Nothing would please me more than to have one of these books of my own but it is a little late in life to start now, so I will suggest to the young man starting out, that he keep a note book in his tool chest. MACHINIST.

HOW SHOULD THIS PATTERN BE MADE?

Editor MACHINERY:

Considerable discussion has taken place in our shop regarding the way in which the pattern shown in the sketch should be made. When I came to work in this shop my first job was to make a pattern of a cap for a 14-inch journal box. The principal dimensions of this cap are given in the drawing and it will be seen that while the inside is semicircular the outside is elliptical. After carefully studying the drawing I decided to saw around the elliptical outside, leaving as little hand work as possible, afterwards sawing out the bolt lugs and fitting them to the cap. One of the patternmakers thought that this was wrong, in fact was not in keeping with good patternmaking. He contends that the lugs should have been worked from the solid and claims that all patterns previously made in this shop have been made in this way. Small bearing caps are, of course, often made from the solid but it seems to me that for making so large a cap my method was the better. I wish that some of my fellow craftsmen would give their ideas on this subject.



The Pattern in Question.

PATTERNMAKER.

ONE OF KRUPP'S ECONOMIES.

Editor MACHINERY:

The recent death of Frederick Alfred Krupp reminds me of some of the things I have been told by a German mechanic who worked in the great Krupp works at Essen in his younger days. At that time, of course, Alfred Krupp was in authority.

One of the economies then practiced, was of such a novel character that I will describe it so far as I know. At that time muzzle-loading cannon were being made. They were bored from solid forgings, leaving the breech solid with the rest of the gun. Instead of boring them out in the ordinary way and converting all the metal removed into chips, a solid core was taken out and afterward converted into an axle or similar forging. The boring tool was similar to a long hollow mill, and cut an annular groove in the gun to the required depth of bore. This in itself seems like an incredible operation, but the cutting off of the core at the breech seems still more so. That it was accomplished without serious difficulty, I was assured by my German friend. How the tool was constructed he could not or would not tell.

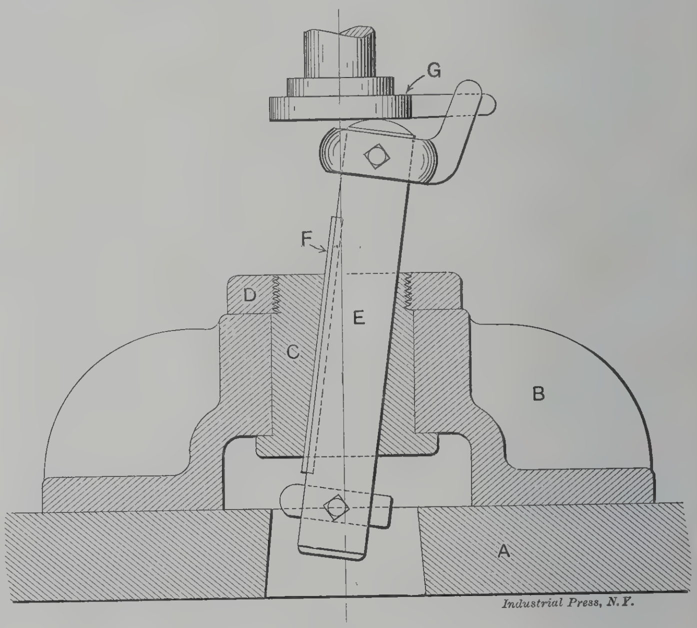
Now, it would scarcely be considered good practice to use the metal from the center of a forging or steel casting for any important purpose, but then conditions were different, and possibly Krupp knew how to insure the integrity of such product. At any rate it indicates something of the wonderful powers of the man chiefly responsible for the development of the greatest European industry. F. EMERSON.

Newark, N. J.

DRILLING TAPERED HOLES ON THE RADIAL DRILL.

Editor MACHINERY:

Some time ago a job of drilling came to my notice which I think will interest some of the readers of MACHINERY. In a large disk, which formed a part of a machine for making mineral briquettes, it was necessary to drill a series of tapering holes that increased in diameter as they receded from the face of the plate. In the figure, *A* represents the plate and the section shows the taper of the holes which were about four inches in diameter at the top. These holes were drilled under a radial drill by the aid of the jig shown in the cut. The cast iron frame *B* was firmly clamped to the face of the disk so that the center line of the jig coincided with the hole to be drilled. The bronze bushing *C* was held by the nut *D* so that it made a smooth running fit in the body of the casting. Through this bushing was drilled a hole making the same angle with the axis of the bushing that the sides of the hole were to make with its axis. The boring bar *E* was free to slide up and down in this hole, but the key *F* caused the bar and bushing to revolve together. On the end of the radial drill spindle was clamped the driving dog, *G*, the arm of which engaged an ordinary lathe dog clamped to the upper end of the boring bar. It will be apparent from the sketch that as the bar was fed downward the hole would be bored to the required taper.



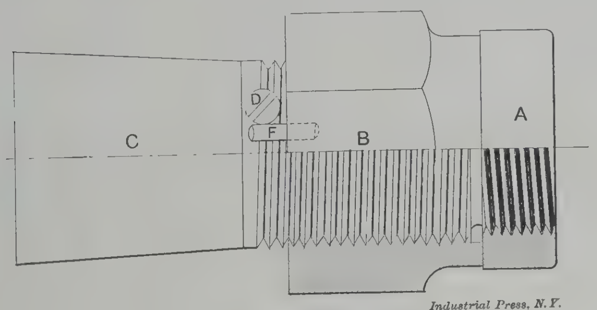
Jig for Drilling Tapered Holes.

Providence, R. I. J. W. PRELL.

SCREW ARBOR FOR TURNING COLLARS.

Editor MACHINERY:

We have as a regular job a large number of threaded collars to be made on the turret lathe. Considerable trouble was experienced in turning these on a solid arbor, owing to the difficulty of removing them when finished. To overcome this trouble, the arbor shown on next page was designed combining, as it does, the stiffness of the solid arbor and the quick action of a split arbor. By the first operation the hole is drilled and threaded and one side of the collar is faced, then it is ready to be finished on this arbor. The shank of the arbor fits the turret and the front end is threaded to a good fit in the collar. Directly beyond this thread is a second threaded section, somewhat coarser than the first and left-handed. This second thread is sufficiently large to allow the hexagon nut to be passed over the first thread. This nut is turned on its front end to a diameter slightly below that of the collar, in order to give clearance in turning the top. As will be seen, the collar butts up against the nut with the left-hand thread and remains secure no matter how heavy the strain put upon it. When, however, the collar is finished, a slight turn of the nut will release all pressure and the collar may be unscrewed with the fingers. Before another collar is placed on the arbor the nut is returned to its first position by bringing the pin *F*, in the nut, against the screw *D*, in the arbor. This arrangement is necessary in order to use the automatic stops on the turret and insure getting all the collars of the same thickness.



Industrial Press, N.Y.

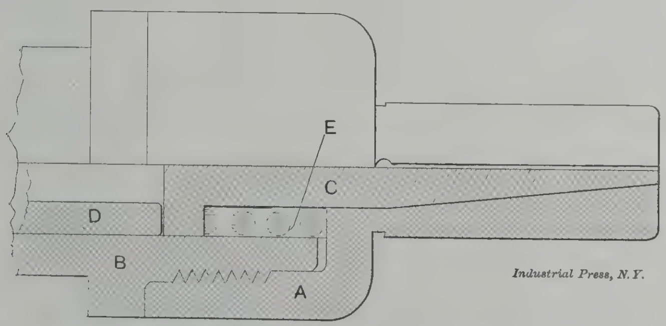
Arbor for Turning Collars.

Lawrence, Mass. CHARLES P. THIEL.

AN EXPANSION CHUCK FOR THE SCREW MACHINE.

Editor MACHINERY:

We were making hundreds of shells 2⅛ inches outside diameter and 1 15-16 inside, on the outside of which it was necessary to perform several operations and make them perfectly true with the hole. We were at first perplexed to find a way to hold these shells but finally solved our difficulty by the adoption of the spring chuck, here shown, which was simple and can be used on any screw machine that is provided with a wire feed. The body of the chuck, *A*, is made of machine steel and four longitudinal slots extend the full length of the portion on which the work is held. When the chuck was made these slots were stopped a little way short of the forward end, leaving a small tie which held the piece in shape while it was being hardened. This was afterward cut through with a circular lap. After these fins were cut away the taper portion and the part that fits the spindle were lapped out so as to be perfectly in line with each other. I then made an arbor to fit these holes and ground off the back of the chuck.



Industrial Press, N.Y.

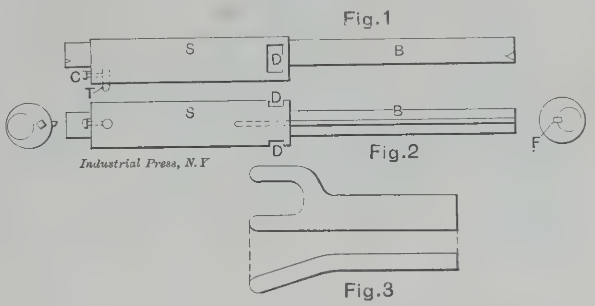
Expansion Screw Machine Chuck.

The plunger, *C*, is made of tool steel, hardened and ground, the length being governed by the wire feed so that the quill of the machine will act the same upon it as it does on ordinary collets. The taper on our chuck was 11 degrees on a side and it was afterward found that this taper was sufficient to cause the chuck to release itself, so that the spring was not needed. Should the taper be made less, however, the spring would be necessary. *B* is the spindle of the machine and *D* the quill which forces the plunger into the chuck. After the parts were assembled the chuck was put in the machine and by the use of a grinding attachment, held in the turret, the portion upon which the work fits was ground and then lapped to a good close fit in the holes in the work. As these holes were all made to plug gage the chuck worked very nicely. In each of the four slots was fitted a piece of fiber which kept out all chips and dirt. J. M. S.

BORING BARS.

Editor MACHINERY:

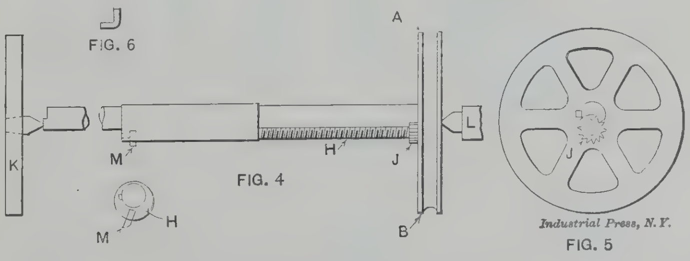
Fig. 1 shows the plan and Fig. 2 the side view of a boring bar that I have used with success for both straight and tapered work. It consists of a bar, *B*, whose centers are offset enough to bring the eccentric sleeve, *S*, central with the lathe centers. The object in making this sleeve eccentric is to make more room for fastening the cutting tool. The bar is splined for about three-fifths of its length and a feather, *F*, fitting tight in the sleeve and sliding in the spline, keeps the sleeve from turning on the bar. The cutting tool, *T*, is held in place by means of the set screw, *C*. Fig. 3 shows the form of driver that is used. The jaws are placed in the slots, *DD*, Fig. 2, and the straight end is fastened in the tool post, like an ordinary lathe tool. The carriage feed is used to feed the sleeve along the bar while the tailstock is set over to get tapers the same as in turning work held on the centers.



Industrial Press, N.Y.

A Convenient Form of Boring Bar.

I also submit a sketch of a rig for re-boring lathe headstock boxes which "Connecticut" asks for in the September number of MACHINERY; this is shown in Figs. 4, 5 and 6. The headstock is left in its normal position on the lathe bed and the plate, *K*, which is supplied with a center, is clamped to the back end of the headstock with its center true with the lathe spindle, thus forming a bearing for one end of the bar, while the other end runs on the tailstock center, *L*. The sheave is securely keyed to the bar and is driven, by means of a rope drive, from any convenient line of shafting. If desired a pulley and belt may be substituted for the sheave and rope. The bar is provided with an eccentric sleeve which carries the cutting tool and is prevented from turning on the bar by a feather the same as shown in Fig. 2. The sleeve is threaded to fit the feed screw for about one and one-half inches on the end that the screw enters, and a clearance hole is drilled the rest of the way through. Fig. 5, which is a section on the line, *A B*, shows how the toothed wheel, *J*, is let into the bar. The toothed wheel is rigid on the feed screw and is turned slightly at every revolution by coming in contact with a bar held in the toolpost for that purpose. The headstock end of the bar is made as shown, for boxes that are tapped out on the back end to receive an adjusting screw, the reduced size entering the tapped hole. By using a cutting tool as shown in Fig. 6, which projects a little beyond the end of the sleeve such a box can be bored and also faced.



Industrial Press, N.Y.

Bar for Boring Lathe Boxes.

Watervliet, N. Y. M. H. BALL.

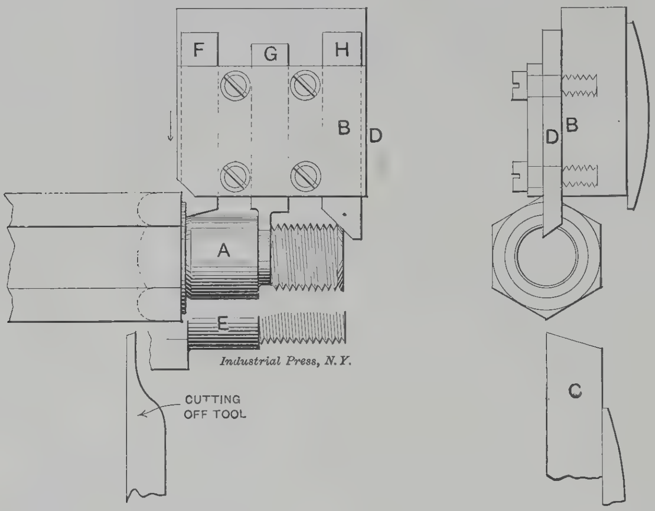
SCREW MACHINE TOOLS FOR MAKING BOLTS.

Editor MACHINERY:

I had several thousands of the bolts shown at *A* to make from hexagon stock on the screw machine. Three turning tools were used and it was found very difficult to keep them set so as to always make the corners square and of the correct length. So I adopted the method shown in the sketch.

This method, which is described here, worked very successfully. The bolts were first turned, nearly to finished size, with the regular turning tools, as shown at *E*. On the back toolpost of the cut-off slide was mounted the tool holder, *B*, in which are set the tools *F*, *G* and *H*. When the bolt had been rough turned, as previously described, these tools were then run up to a stop and the bolt finished as at *A*. As these tools have but little stock to remove they seldom require grinding and therefore save a great deal of time and insure accurate work. After the body of the bolt has been finished as described it is cut from the bar with the cutting-off tool shown at *C*, which while cutting chamfers the corners, at the same time, thus completing the bolt. JAMES P. HAYES.

Meriden, Conn.



Screw Machine Tools for Bolt Making.

A HANDY JIG TO HAVE AROUND THE SHOP.

Editor MACHINERY:

The photograph shows a tool that we made two or three years ago, which does not seem to be generally known or used. It has proved of so much convenience to us that we think a description may be appreciated by others who have similar work to do. As will be seen, it consists of an angle plate which is capable of holding studs of different diameters horizontally or at an angle. It is used for drilling setscrew and oil holes in pulleys, gears and other similar work. The studs, five of which are shown in the photographs, range in size from ¼-inch to 2 inches in diameter. The smaller sizes, up to ⅝-inch, are driven into the backs of the larger ones, thus saving the expense of making complete studs for these sizes.

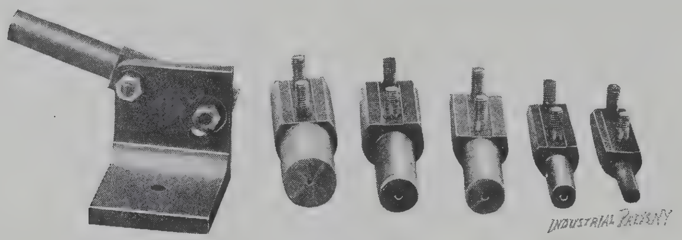


Fig. 1. Jig for Drilling Set Screw and Oil Holes.

As with nearly all new tools, if a second one were to be made it would be different in some respects from the original. The objection to the present tool is that the movement of the studs is somewhat limited, so if another were being built it should be as shown in Fig. 2, in which it will be seen that the studs may be set horizontally, vertically or at any angle between. Fig. 3 is a dimensioned drawing of one of the studs, which will give a general idea of their size, although, of course, the dimensions are varied for the different sizes of studs. They are made from stock somewhat larger than the diameter of the stud required and are turned with as much eccentricity as possible in order to obtain a sufficiently large flat surface for clamping to the angle plate. For work that requires to be held rigidly the studs could be made to expand on the same principle that is employed for expanding arbors or reamers. CORNEIL RIDDERHOF.

Grand Rapids, Mich.

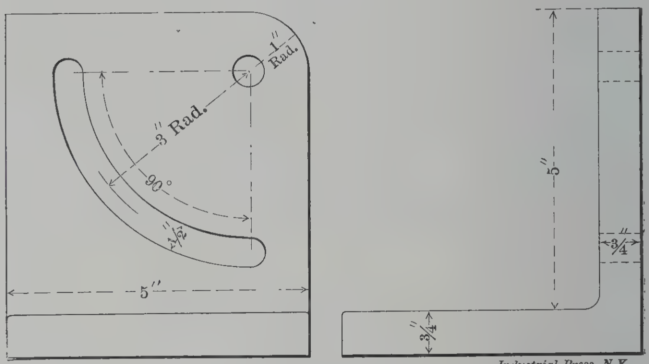


Fig. 2. Base of the Drilling Jig.

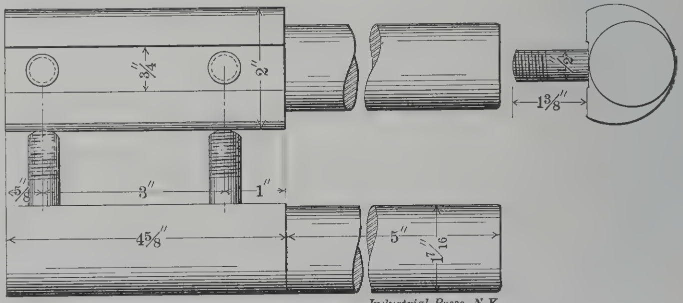


Fig. 3. One of the Drilling Studs.

REGARDING LARGE OIL TANKS.

Editor MACHINERY:

In your publication Vol. 9, No. 1 for September last, under "Notes and Comments" (Engineering Edition) we see it stated that what is said to be the largest steel tank in the world has been completed at Boston for the Atlantic Refining Co., and measures 36 feet high, with a diameter of 90 feet. We, in this country, are specialists in the oil tank line, and think that you will find the following particulars of current contracts which we are executing, of sufficient interest to your readers to merit notice in an early issue of your journal.

Catalogue page 79 enclosed, shows a view of tanks, 58 feet 6 inches diameter, by 30 feet high, built and erected for the Burma Oil Co., Ltd., also tanks, 64 feet diameter, by 34 feet 10 inches high, built and erected for the Standard Oil Co., of New York. These were installed at Budge Budge, the great oil depot for this side of India, and are typical of similar contracts carried out by us in other parts of the country.

Our most important contract at present in progress of execution is for the Standard Oil Co., of New York, and consists of two steel tanks each 90 feet diameter, by 38 feet 6 inches high to top of roof. The capacity of each tank is considerably over 1,250,000 gallons. The bottom, which is double-riveted, weighs 46 tons and is composed of 67 plates ⅜-inch thick, maximum sizes rolled being used. In this part of the work there are 15,200 rivets. The maximum size of plates has also been used for side of tanks, there being 13 plates in circumference; the bottom strake is 9-16-inch thick, each plate weighing 3,360 pounds. There are 240 ⅛-inch plates and 12,500 rivets in each roof, the net weight of rivets in a tank being 15,680 pounds.

For the above and for other oil companies we have, in the aggregate, close on 100 smaller tanks actually in hand at present, for erection all over India. Each tank is built up from the imported raw material. Our works, we may say, have an area of 35 acres—exclusive of our drydocks and saw mills.

Howrah, India. BURN & Co.

[The item referred to, is in error as regards capacity and as being the largest, even in this country. The maximum capacity of a tank 90 feet in diameter and 36 feet high, is about 34,260 barrels of 50 U. S. gallons, capacity. Mr. H. C. Folger, Jr., of the Standard Oil Co., informs us that a number of oil tanks have been constructed in the United States to hold 50,000 barrels and some even larger. The very large tanks are in the Texas oil fields.—EDITOR.]

METHOD OF MACHINING SLIDE VALVES.

Editor MACHINERY:

The economy of milling over most planing operations is pretty generally understood, and we are very much in favor of the duplex face or butt mill type of machine. The machining of an ordinary slide valve is one of the operations for which we have lately used the miller. The work was for many years done by planing, and as large numbers were made, suitable fixtures were used so that several could be machined at once. They were also done at piece work, so we may infer that the planing was accomplished in a reasonable time, one and one-half hours being the average.

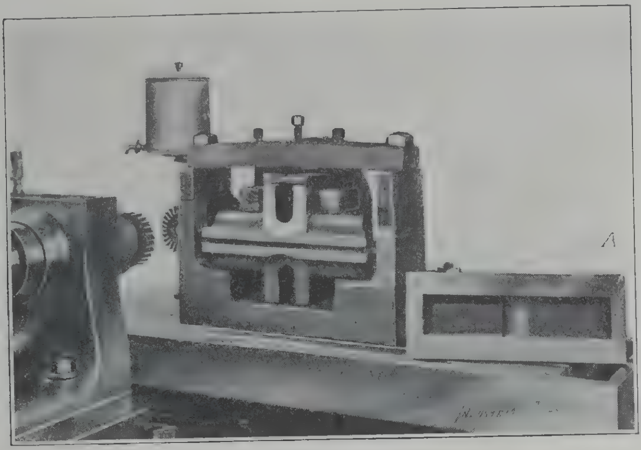


Fig. 1. Machining Slide Valves, First Operation.

The first operation, illustrated in Fig. 1, is to mill the edges of the valves at *A*, it being essential that the edges shall be parallel with the exhaust port. To accomplish this the valves are placed, one on the top and one on the bottom, of the steel plate on which are bosses the same length and width as the exhaust ports into which they fit. This plate, bearing the two valves, is then fitted into grooves in the milling fixture so that the valves are held with the exhaust port parallel with the travel of the machine. In this way the first operation is performed on both sides of two valves simultaneously.

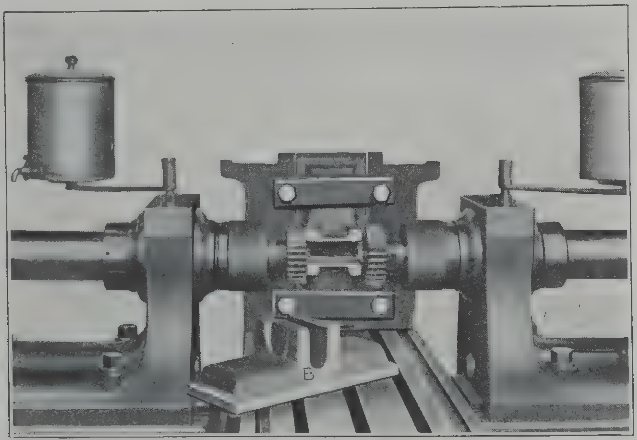


Fig. 2. Machining Slide Valves, Second Operation.

The second operation is to mill the valve stem lug *B*, Fig. 2. The fixture in which this operation is performed is simply an angle plate with a groove planed in its face the same width as the valve. In this plate the valve is held by a pair of latch clamps which have a spring under them, holding them up in position so that but a single turn of the clamping nut is required to clamp or release the work.

The next operation, which is to mill the face, is performed in the fixture shown in Fig. 3. This fixture is an I-shaped chuck having a row of setscrews on top, along its two edges, by which the work is securely held. This is the most particular part of the job and the cutters need to be in best condition and the feed must not be forced too much, but in this operation eight minutes only is consumed in finishing the face of the two valves.

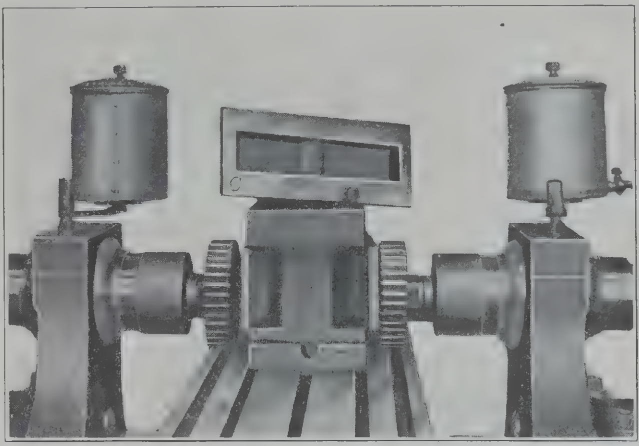
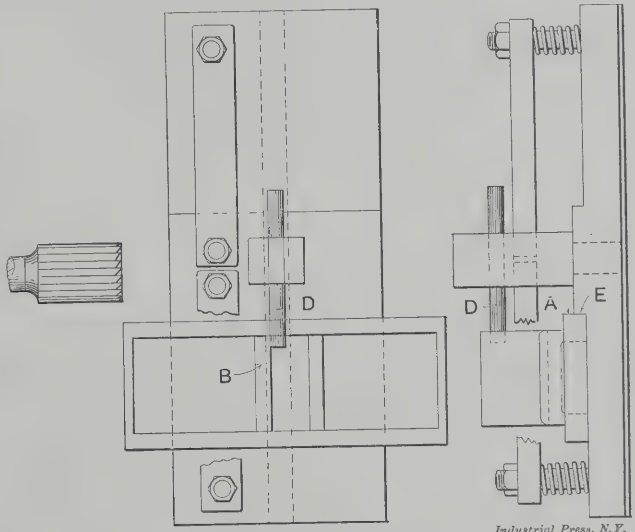


Fig. 3. Machining Slide Valves, Third Operation.

The fourth operation, which completes the work, is to mill each end at a given distance from the center. This is performed with an end mill, on an ordinary plain miller, the valve being held in the fixture shown in Fig. 4. One valve is shown in position, the valve stem lug *B* being held against the stop pin *D*, while the edge *A* is held squarely against the planed shoulder *E*. The second valve is held in the other half of the fixture in the same manner, so that while one piece is being milled another piece is being jigged and the machine need not be stopped until the entire lot is completed.



Industrial Press, N.Y.

Fig. 4. Machining Slide Valves, Fourth Operation.

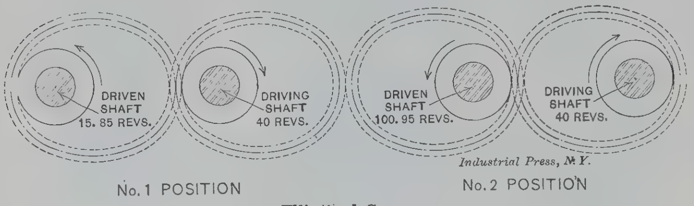
The operators on the machines were apprentices in their first year, at $1.00 per day, and they completed the lot of valves in twenty-nine minutes each. Of course the writer regulated the speeds and feeds of the machine, as well as the speed of the boy. A. A. AVERY.

Warren, Pa.

ELLIPTICAL GEARING.

Editor MACHINERY:

The builders of presses and other machines for the press working of metals do not seem to place much value on what is called the element of time in the construction of their machines. Forming tools, punches and other tools that are used in changing the form of metals, have in most cases the chopping movement, going down to the work as fast as they go up, advancing at the same speed as they recede. A slow movement of the punch or forming tool is valuable in several ways. It prevents sudden strains from injuring the press, favors the punches and dies, allows them to be run longer without having to be ground or replaced, and in a great many cases permits the use of a less expensive metal for the tools. During an experience of many years in using and building presses, the writer has become strongly attached to the use of the elliptical gear. These, while giving the powerful alternating leverage, the slow advance and the quick return, are capable, when properly designed, of furnishing as much or as little of the element of time as may be desired.



Elliptical Gears.

The sketches show a pair of elliptical gears in the two effective positions and illustrate the slowness with which the tool is forced through the work and rapidity with which it returns to position for the next stroke. These gears have a leverage of about 2½ to 1. The large end describes a circle, the diameter of which is equal to that of a 53 tooth gear, while the small end moves in a circle whose diameter is that of a 21 tooth pinion. No. 1 position shows the relation of the gears when the punch or tool is being driven down at a rate of 15.85 revolutions per minute. No. 2 position, when the tool is being withdrawn from the work at the rate of 100.95 revolutions per minute.
E. M. Lehman.

Chicago, Ill.

A HOME-MADE T-SQUARE ATTACHMENT.

Editor Machinery:

In every draftsman's daily work he has continually to use his triangle at angles other than those found on the regular 30-60 and 45 degree triangles. For this purpose I have made the attachment shown in Fig. 1, which has proved very useful in a great number of cases. The base *A* is made of a piece of wood about one-quarter of an inch thick and ten inches long. In the center of this base is firmly fastened a thin strip of steel carrying at its top the thumb tack *B*, which serves as a pivot for the triangle *C*. About this pivot the triangle is swung into any desired position, after which it is held in place by means of the retaining strip *D*. This strip is pivoted to the triangle at *E* and is held down to the base of the attachment by a thumb tack passed through one of the holes *F*, *F*, *F*. In this way the triangle may be held firmly in any position desired, and it may be easily set at any required angle by the use of a protractor. A few of the useful applications of this attachment are shown in Fig. 2 and many others will suggest themselves to the draftsman as he becomes familiar with the use of the instrument.

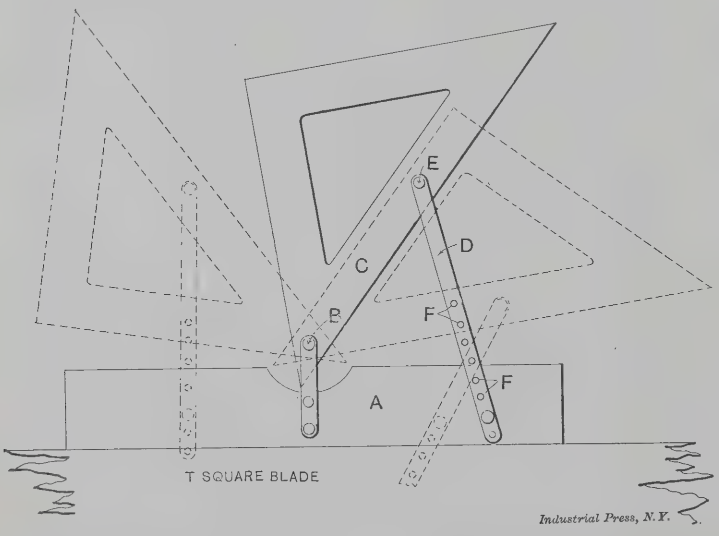


Fig. 1. A Handy Attachment for the T-square.

In constructing this arrangement any 45 or 30-60 triangle can be used and for the strips I employed pieces of an old hack saw, but strips of brass or other metal will, of course, answer the purpose equally well.
A. McA.

RIGHT AND WRONG WAYS.

Editor Machinery:

While working in different shops in this country, in England and France, various examples of the right and the wrong way to do a job have come to my notice and I think that some of these cases may be of interest and possibly benefit to the readers of Machinery.

An order came into the shop one day for a lot of screws, about three feet long by two and a half inches in diameter, having six threads (or a sextuple thread). The turners were on piece work and started cutting them in the usual way, by dividing the change wheel into six equal parts and cutting thread by thread. One, however, more enterprising than the rest, made a gage which was as long as the lead, and had six equally divided spaces in it, which were equal to the spaces between the threads. Next he got six tools forged and ground to the right dimensions and fixed these on the rest so that each one would just go into a space in the gage and were all in line; then putting in the change wheels, he started the lathe and cut *the six threads all at once.*

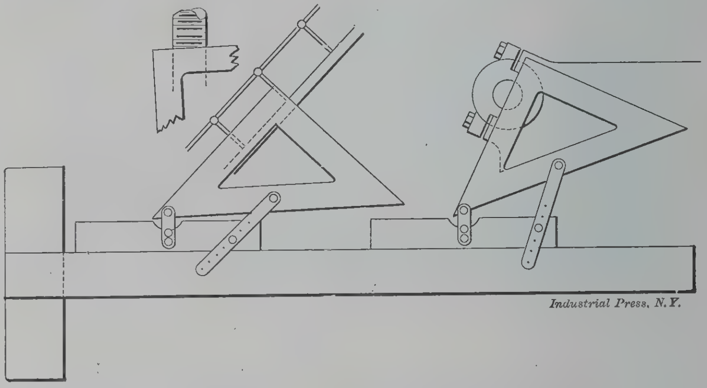


Fig. 2. Some of the Uses for the T-square Attachment.

I remember a lot of bolts being made about 12 inches long by two inches diameter, threaded at one end, with a hexagon head at the other. These were faced up and the centers thereby turned off. It was then found best to turn them down a little in the middle as they fitted too tightly in the holes. It looked as though all those bolts would have to be centered again before the turning could be done, so they were taken to the lathe man and he was told to go ahead—and go ahead he did. He found a short box spanner which would fit the bolt head and this he put in the chuck jaws, setting it to run true. Next he got a steady rest with two semicircular wooden blocks which just fitted the threaded part; these were lined with tin to prevent the threads from cutting the wood out. Having everything ready he picked up a bolt, put the head in the box spanner, and the screwed end in the steady rest, started the lathe and put the cut on at once. The tool traveling toward the headstock pressed the bolt into the box spanner, and so prevented it from working out. One cut across was enough to take off the required quantity of metal and he finished those bolts in such short time that the foreman would hardly believe his eyes when he saw them turned and yet uncentered.

He was a bit different from the man who, when given some left-hand screws to cut, set to work and rigged up the lathe to run backwards, turned the tool upside down, and proceeded to cut what he thought would be a left-handed screw. He must have been considerably astonished at the result.

A few years ago a hydraulic press had to be moved—it was a large one of about 800 tons pressure. The ram was in the bottom casting, and the top was held up by four large columns. The man who had charge of the job went to a lot of trouble to get it apart; he got derricks, ropes, blocks, etc., had a regular gang of laborers and, in time, with a lot of shouting and bossing he got it to pieces. It was then erected in the new place. Lately it was taken down to make room for a more powerful machine and a young mechanic was put in charge. He didn't cut off the water pressure first of all, then get derricks, etc. No! he took the four nuts off the top of the press, put a lot of packing on the press table, opened the valve and as the ram went up it lifted the top casting clear of the columns. This top was then barred through 90 degrees and the ram lowered, which let it down between the columns. The ram next brought it down to the level of the floor and it was rolled away to the crane. Next a crosspiece was fixed to the ram table and to the two opposite columns, the lower nuts were taken off, the ram sent up, and it pulled out the two columns which were allowed to fall to the ground, being guided by ropes. In the same way the other two were removed. The ram was next lifted up as far as safe and secured from toppling over by four ropes, after which it was pumped completely out of the hole, the ropes slowly slackened allowing it to fall to the ground. The water pipes were now disconnected and the bottom casting lifted by hydraulic jacks. All this took the mighty force of the mechanic and his laborer; no derricks, blocks or special tackle were used; only a few ropes, and it was done in about one-sixth of the time it took the other man, who had worked hard but did not think.

That reminds me of a man I knew who had to repair a double cylinder engine, and after taking it to pieces and doing the necessary repairs carefully put it together, gathered up his tools, just started the engine to make sure it was all right, and I think he was the most surprised man in that State when he saw the engine run—well, but the wrong way. After using up a lot of brain energy it dawned on him that the crankshaft and cranks were turned end for end. He was in a nasty temper for the rest of the day.

In placing a steam valve, remember there is a right and a wrong way to connect it up. I have known many cases where they have been placed upside down. The valve should always be placed so as to close against the in-flowing steam, that will cut off the steam from the side of the valve where the handwheel and stuffing box is located, so when the packing gets worn it is only necessary to close the valve and repack. If the valve is put in the other way it is impossible to pack it without shutting off the steam at another valve, which is generally inconvenient.

There was once a steam pump, pumping water to a high tank with the inlet pipe at the bottom of the tank. The pump did not work well, and the boss, after long consideration, decided that there was too much *weight* of water to pump against. So he had the inlet pipe removed from the bottom, another length joined on, and turned over the top of the tank. Thus the water would be pumped over the top and run into it. He could never understand why the pump instead of being better was worse, if anything, after *easing*(?) the load so much. It was a pity he never studied elementary hydraulics.

I have noticed lately there has been a lot of discussion about making things theoretically and not practically correct. I have seen many cases of this; one was where a draftsman, after using his slide rule and table of "Strengths of Materials," designed a cast iron hydraulic cylinder for low water pressure to be cast with the wall three-sixteenths of an inch thick by twenty inches in diameter. It was quite strong enough theoretically and did not (or would not, for it was cast five-eighths) use much metal. But for all that, he fell a good deal in the chief's estimation.

He was nearly as bad as the draftsman who was preparing drawings for some machinery. A brick wall which was to be two and a half bricks thick, came between some of the parts. A brick is nine inches long and nine inches multiplied by two and a half equals twenty-two and a half inches. This he put down as the thickness of the wall. *He forgot the mortar*, and when the wall was built it was twenty-four inches thick, which made such a difference to the machinery that a lot of alterations were necessary.

Mistakes like these are, in my opinion, due to the draftsman not having enough practical experience. The great majority only just rush through the shops doing patternmaking, machining, and fitting (no molding as a rule) in about a year, then they think they have had a good, varied, practical experience.

GEO. P. PEARCE.

Williamsport, Pa.

A FRICTION CLUTCH PULLEY AND THE JIG FOR TURNING THE FRICTION SHOES.

Editor MACHINERY:

The photograph, Fig. 1, shows a special chuck that is used for turning clutch shoes and Fig. 2 shows the friction pulley in which these shoes are used. When the clutch was designed these shoes were fortunately made to take up a little less than 90 degrees, making it possible to place four in a circle. I say "fortunately" because it was not done with that purpose in view, as we expected to build a revolving fixture for the milling machine and mill them as we are doing with the shoes for a smaller size of these clutches. But as there was already more milling than our capacity conveniently allowed we were compelled to resort to the lathe and, although it is not possible to tell whether or not the miller would have done the work quicker, it is sure that we are well satisfied with the amount of work turned out with this chuck. It is fitted to the faceplate with eight dowels, and four capscrews tapped into it from the back hold it fast.

Here let me say a word about dowelling special chucks to a faceplate. Some do not like the practice because it impairs the "looks" of the faceplate. This is true, in one sense, but it is also true that "handsome is that handsome does" and the time saved by dowelling as many as possible of the special chucks to the faceplate would pay for another if one were bound to have one not perforated with dowel holes. When a number of chucks have been dowelled to a faceplate it is often difficult to find the right holes, even if they have been numbered. This is usually caused by numbering too many of the holes and using the same number more than once. It is neither necessary nor desirable to number more than two of the dowels and corresponding holes for each fixture, as when these are found the rest of them will, of course, drop in. When the first fixture is dowelled to a faceplate two of its dowels should be marked 0 and 1, two of the next one 2 and 3, etc.; there will then be no trouble in finding the right holes and the faceplate will look at its best when a large number of holes indicate that it has been made "good and useful." The foregoing relates only to that class of chuck that cannot very well be made to screw onto the spindle nose in place of the faceplate.

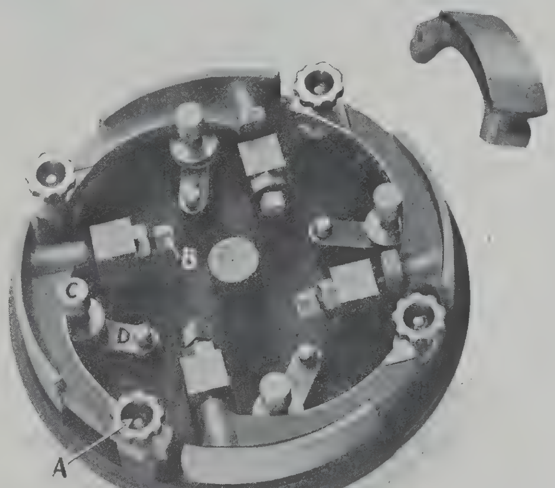


Fig. 1. Jig for Turning Clutch Pulley Shoe.

To return to the chuck in question, it is principally different from many others in that neither wrenches nor measuring tools are needed in its use. As the four quarters of the chuck are identical, but one needs be considered in describing it. The fulcrum end of the shoe, having been previously milled with straddle mills and drilled, is placed on the stud in the chuck and the nut, *A*, tightened by hand while the other end of the shoe is left some distance away from screw *B;* then, pressing the shoe down onto this screw the nut *A* is "helped along" tightening it firmly. Screw *B* was adjusted when the chuck was made and is not again disturbed. Collarscrew *C* is now unscrewed till its collar touches the back side of the rib on the shoe and levernut *D* is tightened to lock it. This supports the shoe against the side pressure of the tool, which is fed toward the faceplate. The clutchshoe is now firmly held and the tool being adjusted to a setpiece on the chuck, a roughing and then a finishing cut are taken. The force of the cut presses the piece firmly down on screw *B* and there is no tendency to tear away. Although these shoes are to be faced with leather it is essential that the outer surface conform as nearly as possible to the clutch rim on the pulley. Should it fail to fit the rim the leather would engage it at one end only and the pulley would be crowded to one side on its sleeve and, less surface being in contact, the clutch would not drive so well.

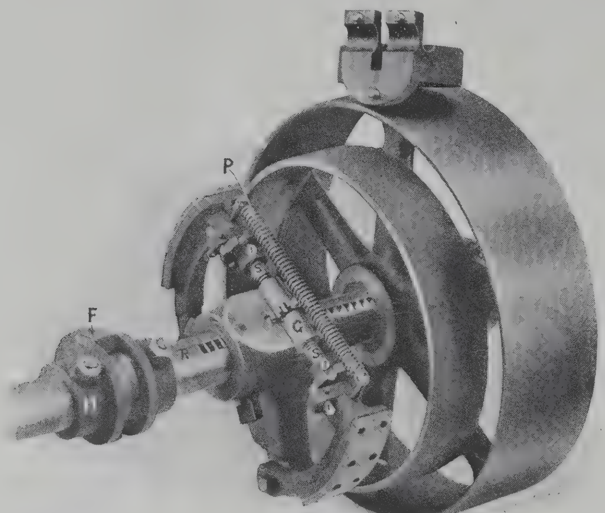


Fig. 2. Clutch Pulley.

The construction and action of the clutch in which these shoes are used is so different from any other that a brief description of it may be of interest. In the photograph, Fig. 2, the pulley has been slipped back on the shaft and the cap removed from over the gear to expose the working parts to view. A rectangular groove is milled in the shaft and therein slides a toothed rack *R* meshing with gear *G*. The rack is attached to a grooved sliding hub *H*, which is moved laterally in the usual manner by fork *F* on the shifter rod. Gear *G* has a long hub, one end of which is threaded right and the other left hand. The screws *SS* are held from turning by the lockpins *II*, each engaged in a notch of the disks *DD*, which are fast on the screws. When the gear rotates the screws the shoes will be either forced outward or allowed to be drawn inward by the spring *P*, according to the direction of rotation. When the leather wears away so sliding hub *H* will reach the hub of the clutch before the shoes are expanded sufficiently, the cotterpins passing through lockpins *II* are withdrawn, and the expanding screws *SS* may be turned to another notch and again locked. This adjustment is readily made without the aid of any tools. It, however, needs be made but very seldom as the latter is very durable when in contact with metal and the old story of a rawhide lace-leather hanging over a line-shaft and wearing it in two is not entirely without foundation.

When these clutches were first designed there were some doubts concerning the enduring powers of leather, so, as I preferred leather to wood or fiber, a preliminary test seemed advisable. A countershaft for a lathe being equipped with a pair of clutchpulleys its shifter rod was connected through a bellcrank to an improvised crankpin on the faceplate of another lathe and when it had been reversed considerably over one hundred thousand times under a heavy load the leather was found to be reduced one-hundredth inch in thickness. This was some eighteen months ago; the countershaft has been in daily use since and there appears to be several years of service left in the leathers. The principal beauty of this clutch is the very small effort required to operate it, as the clutchshoes are actually *screwed* into contact with the clutch rim so that with the tip of the little finger at the shifter lever the clutch may be engaged tight enough to slip the belts.

Although designed primarily for use on friction countershafts for machine tools its good points have introduced it in other establishments and even in woodworking shops it is preferred to the common tight and loose pulleys. Some of them used at woodworking shops are running at 800 to 1,100 turns per minute, a speed reached successfully by very few friction clutches. CORNEIL RIDDERHOF.

PATTERN FOR AN OBLIQUE CHUTE.

Editor MACHINERY:

Pattern makers occasionally meet with problems that are exceedingly perplexing, especially to those who have neglected the study of geometry; moreover such problems are often by no means easy to solve even by those fairly informed in that science. Fig. 1 shows the pattern which is the subject of one of those problems. A cast iron chute rectangular in section is required to pass in an oblique direction through a brick wall 17½ inches thick. It passes through at an angle of 35 degrees with the perpendicular and 45 degrees with the face of the wall. As the illustration shows, the chute emerges from the wall with its sides parallel with the vertical joints of the brick work, but its top and bottom are oblique to the horizontal joints of the wall. This obliquity results from the combination of angles and the rectangular section of the chute. There are several ways of determining the length of the pattern and the angle of its ends in such a case, and two of these ways will be described.

In order to obtain the proper dimensions and angles of the pattern it is advisable to lay down full size the necessary views, as illustrated in Fig. 2. First draw the plan *A*, making *a* equal to the thickness of the wall and *b* equal to the base of the required triangle horizontally. In this case the horizontal angle being 45 degrees makes both sides of the triangle 17½ inches. Draw the line *d* parallel with the hypotenuse *c* and make the perpendicular distance between the two lines equal to the external width of the chute, 14 inches, and extend *d* to *e*. Draw the side elevation *B* equal to the thickness of the wall, making the line *f* 35 degrees with the perpendicular. Project a line from *g* toward *h* and extend it indefinitely. Project the point *i* toward *k* and extend it indefinitely. Project the point *l* and intersect *i k* at *k;* connect *k m*, this line will give the angle of the chute through the wall when viewed in front elevation. Project the point *e*, and intersect the line *g h* at *h*. Project the point *n* toward *o* and extend it indefinitely. From the point *h* draw the line *h p* parallel with *m k* intersecting *n o* at *o*, connect *k o* and the length of the line so formed will equal the length of the angular side on the top and bottom of the chute at its ends. So far while we have arrived at the width of the chute, also the angle of the ends on the top and bottom, there is no line that gives the actual length of the chute, because to obtain that it is necessary to have a view from a point perpendicular to the side; the side being obliquely viewed in

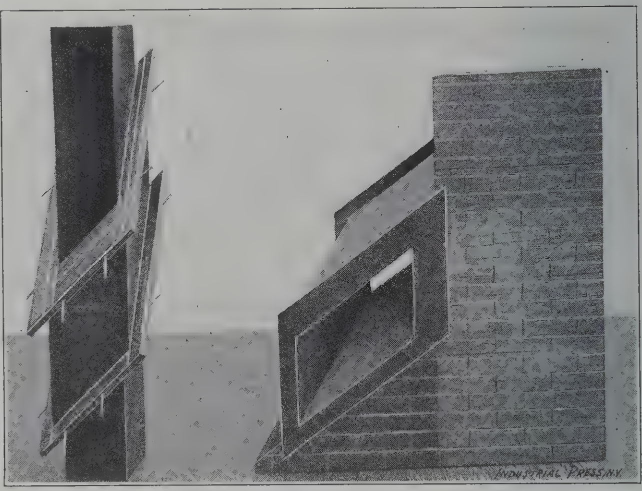

INDUSTRIAL PRESS, N.Y.

Fig. 1. Pattern for an Oblique Chute.

that which has been drawn. The actual length of the chute through the wall is the diagonal line, or hypotenuse of the angle whose sides are the line *f* and the length of the thickness of the wall *q*. Draw *q* perpendicular to the end of *f* making the length equal to the thickness of the wall, connect the extremities of *f* and *q* and the hypotenuse *r* will equal the actual length through the wall, and between the flanges of the chute; this line also furnishes the basis for obtaining the angle of the ends of the chute on its sides. With the length of the line *r* intersect *g h* at *s* and *i k* at *t*, and draw *t u* parallel with *n o*. Draw *v* parallel with *r* making the perpendicular distance between the two lines equal to the external thickness or depth of the chute. Let *v* intersect *t u* at *u*, the length *t u* will then equal the depth of the end of the chute where it emerges from the wall, and the angle so formed will be the angle of the ends on the side of the chute. Project and make *k w* equal to *t u;* from *w* draw *x* parallel with *o k* intersecting *n o* at *y*, and the rhomboid so formed by *k o* and *w y* will be the figure of the end of the chute, minus the flange, when viewed perpendicular to the end, as it emerges from the wall. Having determined the most important part of the problem, and proper length and angles for the pattern, its construction is not difficult. The pattern complete except the core box, which is a plain rectangular one, is shown at the left in Fig. 1.

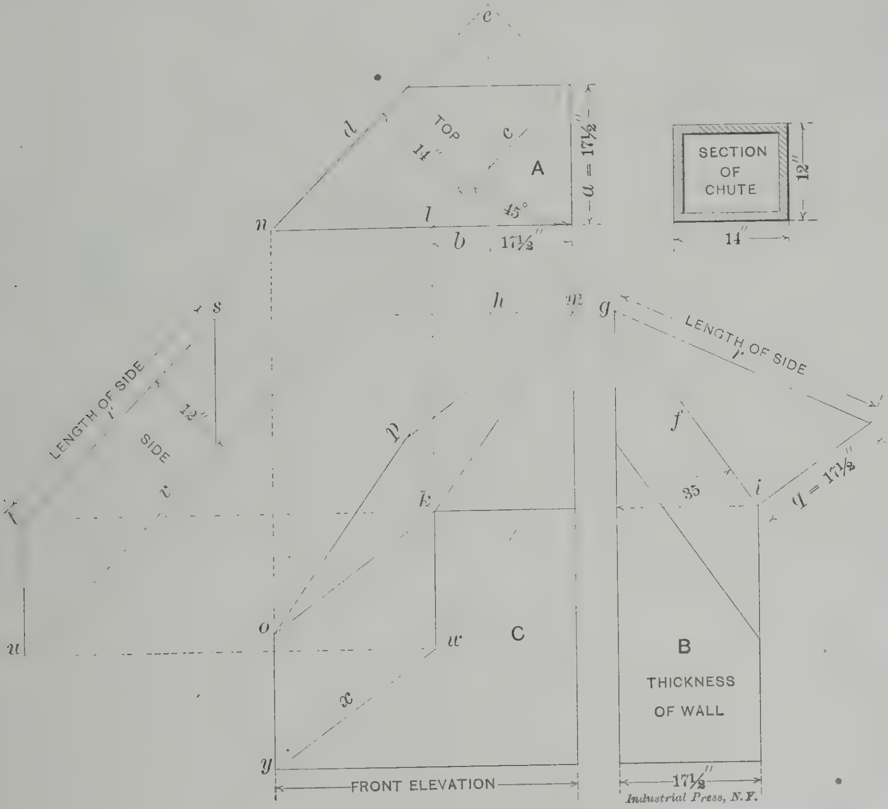


Fig. 2. Development of Pattern for Oblique Chute.

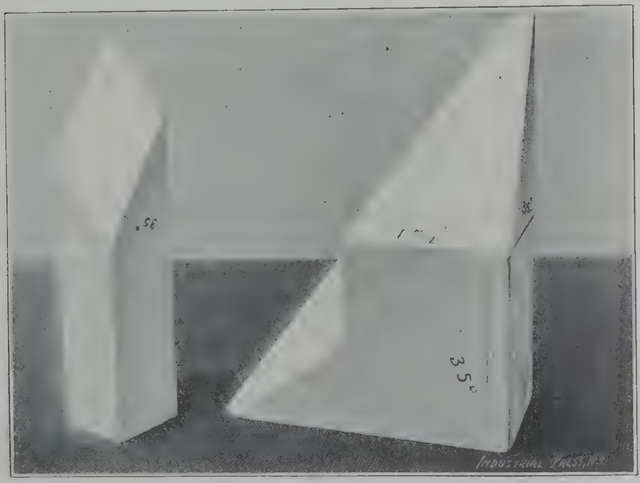


Fig. 3. Wooden Model for Oblique Chute Pattern.

To begin the pattern a box or core print whose cross section equals that of the interior of the chute, is built up of one inch material; the length of the print is sufficient to allow bearings for the core beyond the flanges at each end. Upon the print the length and angles of the pattern are lined off and the thickness for the metal planted on in conformity with the lines. Where the thickness forms undercuts, as at one end of the sides, the undercut pieces are made to be drawn separately from the body of the pattern; they are secured in place by draw pins. After the thickness is completed the flanges at the end are fitted to the pattern and secured by draw pins; they remain in the sand and are drawn after the body of the pattern has been lifted from the sand.

Another way which the writer has often used with great advantage and unvarying success in working out difficult problems of this character, is to make a wood model to a convenient scale and develop the object from it. He would especially recommend this method where a number of different angles are involved, because it enables one to comprehend the problem more readily by having the chief features of the object under view, thereby impressing them more deeply on the mind and making mistakes less liable.

Fig. 3 shows a model of all that is necessary to solve the present problem, and in making the pattern it would save tenfold time spent in making the model. It is not necessary that such models should be very elaborate, but accuracy is absolutely essential. It so happens in this case that the angles of the ends of the chute agree with those with which it passes through the wall, 35 degrees and 45 degrees, or so near to them that they answer practical purposes; but this result does not follow as a rule for any combination of angles.

A problem of the foregoing character was once submitted to the writer after its solution had baffled the efforts of several excellent draftsmen for a number of days, and he solved it with the aid of a model, which required less than two hours to make.

Washington, D. C. I. McKim Chase.

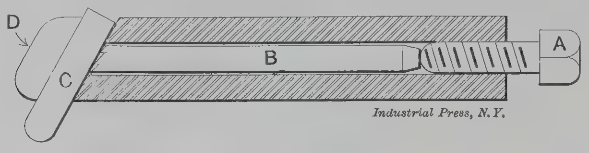
* * *

British engineers quite properly take pride in the durability of their machinery. They intimate that the American habit of scrapping machinery long before it is worn out, is a trick to deceive, and that such machinery is scrapped because it actually had to be, to prevent deterioration of the product. This is, of course, untrue, but it is true in many cases that American design is not as durable as it should be. This fault, however, is being generally corrected without going to the British extreme. A great ado has recently been made in England over the record of a Stephenson locomotive that was put in commission in 1822, and, at last reports, was still running. Such durability is of an extremely expensive kind, as we have time and time again demonstrated in the operation of American railroads—railroads that have the cheapest freight rates in the world. The old engine had been rebuilt so that little if any of the original remains. As to durability, which appeals to the practical American engineer, any mentioned by Mr. J. Davidson in a paper read before the Liverpool Engineering Society, is a good type. He referred to a Willans engine that had run five years in which time its crankshaft had made 535,000,000 revolutions. The crosshead pin was found to be worn in one part only .002 inch, and the connecting rod brasses had worn only .02 in the five years of service. Such a condition indicates good design, first-class fitting and excellent care on the part of the operating engineer.

CONTRIBUTED NOTES AND SHOP KINKS.

BORING TOOL HOLDER.

E. M. Burgess, Springfield, Ohio, sends a sketch of a holder for inserted cutters to be used in boring in such close quarters that a setscrew placed on the end or side of the holder would be in the way. This holder has a hole running from the back end into the tool channel, the hole being tapped at its outer end for the setscrew *A*. A piece of tool steel *B* with its end beveled and toothed extends from the setscrew up to the tool which it clamps firmly. The end *D* being solid can be made considerably thinner than if it was drilled and tapped for a setscrew.



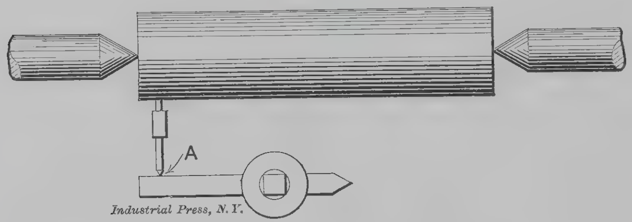
CENTER REST KINK.

Referring to the "kink" in the October MACHINERY, relative to setting work in the center rest, A. C. Muff, Los Angeles, Cal., writes: My method of doing this is to bore out the center rest to the nearest even dimension, using a boring bar held on the lathe centers. Then, when a shaft or other piece of work is placed in the rest a pair of inside calipers is set to the difference between the diameter of the shaft and the bore of the steady rest, and by measuring from the bore the work is very readily brought to a central position.

At our shop we have eight lathes, ranging in size from 8 to 48 inches, and on none of these was the center rest bored out when it was received from the factory. Within a short time I have bored out center rests made by several different lathe builders, and each time I was surprised to see how universally negligent builders are in the construction of this part of the lathe. Not only were these rests left in the rough, but some of them were about a quarter of an inch eccentric. Also the guides for the jaws were not milled accurately and the jaws, when set for small sizes, presented different faces to the work than when set at their largest capacity.

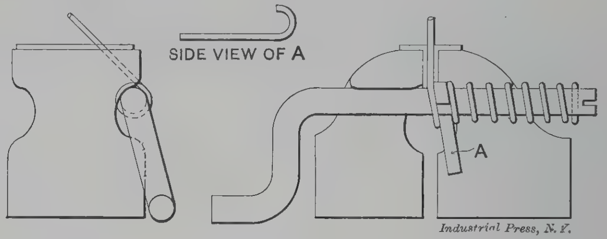
LINING UP THE TAILSTOCK.

E. M. B. sends a "kink" for lining up a tailstock after it has been set over for taper turning. Select a perfectly straight and true arbor and put it in the centers of the lathe. Then put a punch mark in the side of a lathe tool, near the back end as at *A*. This tool is put in the tool post so that it is approximately parallel with the arbor and so that the punch mark is about on a level with the centers. Placing one end of an inside micrometer caliper in the punch mark, measure the distance from the tool to the arbor when the carriage is close to the headstock. Run the carriage down to the other end of the arbor and adjust the tailstock to the micrometer. By repeating this operation two or three times the centers can be lined up in a very few minutes.



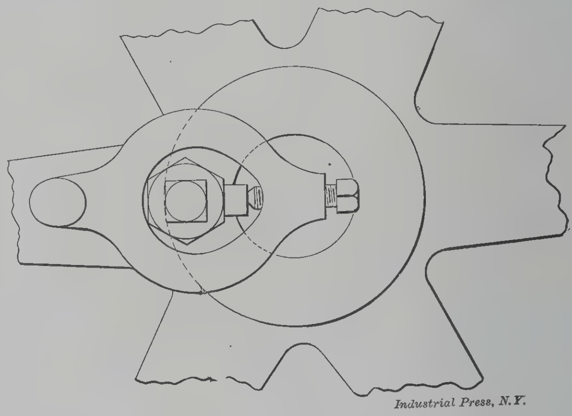
WINDING SMALL SPRINGS.

A. C. Muff, Los Angeles, Cal., describes an ingenious and simple way for winding small springs in a vise. In the first place a rod of the diameter of the inside of the spring is bent to form a crank and a small hole drilled in one end to hold the wire while being wound. This rod is placed at one side of the vise, as shown in the sketch, and one end of the wire passed through the hole in the end while the other is led up through the copper jaws of the vise, which are set so as to make an easy fit for it. To get the proper pitches a piece of metal, *A*, the width of which equals the required distance between two coils of the spring, is bent to a half circle at one end while the other is left long, forming a tail. This is hooked over the mandrel at the point of bending and feeds it along at the desired pitch while the tail strikes against the vise and is thus prevented from turning. When no drill is at hand for drilling the hole in the end, a slot may be filed to answer the same purpose. In this manner the writer has been able to wind all kinds and pitches of springs when doing repair work miles away from a lathe or any tools other than a vise and file.



PULLING A TIGHT KEY.

James F. Willey, Jeffersonville, Ind., in sending in a "kink" says: An aged blacksmith once told me that the best "kinks" could be learned from workmen of very ordinary ability. Whether this be so or not, the one which is here illustrated I saw used by a man whose reputation for quick wit greatly exceeded his skill as a mechanic. He wished to remove a tight key for a pulley on the end of a shaft and the way he did it is shown in the sketch. With a lathe dog a hexagon nut was clamped tightly against the projecting end of the key and a setscrew was then turned through the nut. The end of this screw bore against the hub of the pulley and as it was turned it raised the nut and consequently drew the key with it.



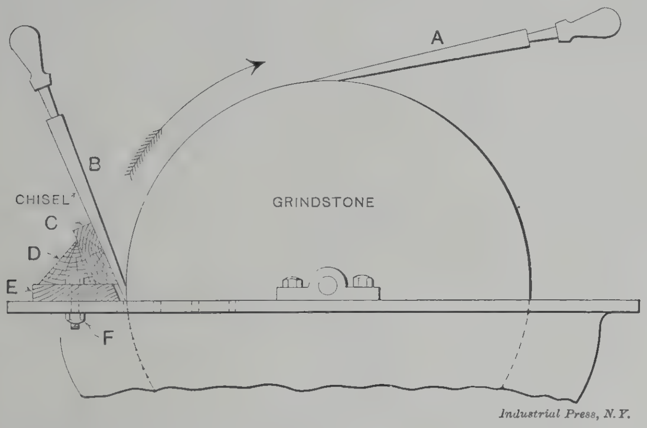
A REAMER KINK.

Charles F. Brandon, Hartford, Conn., sends the following reamer kinks regarding which he says: They would probably be out of place for a first-class tool job but for ordinary work they are frequently very handy. It is often required to ream a hole slightly larger than the size of the reamer at hand. To do this we employ a piece of drill rod about 1-64 inch larger in diameter than the depth of the reamer flutes and long enough to extend through the hole and project a few inches on either side. This rod is thoroughly lubricated and inserted with the reamer in the hole. The reamer is operated in the ordinary manner and the rod crowds it to one side sufficiently to cause it to cut the hole slightly large. Should the enlargement not be sufficient a larger rod may be used or two rods may be put in flutes near together.

A reamer that has become slightly dulled may be sharpened without grinding by the use of a piece of Stubs' drill rod ⅛ to ¼-inch in diameter, depending on the size of the reamer. One end of this rod is hardened as hard as possible and this is inserted in the flutes with the side pressed firmly against the cutting edge of the blade. This is slid up and down a few times against each blade and has the effect of raising a slight burr on the blade which causes it to take hold well and to cut a smooth hole.

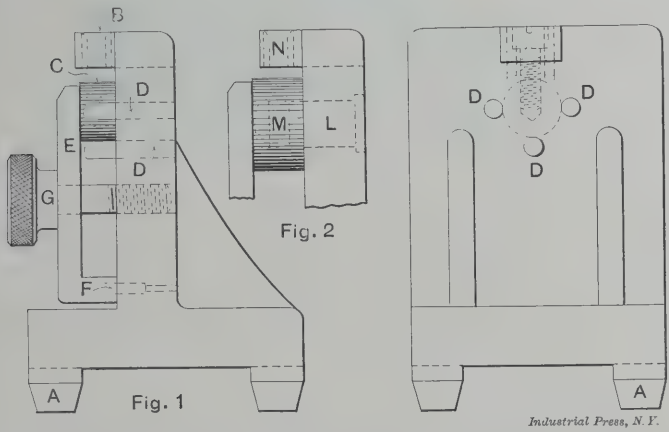
JIG FOR GRINDING A CHISEL.

Woodworker writes: Patternmakers and woodworkers who grind chisels, plane irons, etc., in the old way by holding them on the stone as shown at *A* will find the little jig, for holding them as at *B*, to be a great convenience. The two pieces, *C* and *D*, are screwed or nailed together and braced by the bracket *E*. Then the piece *C* is beveled to give the proper angle to the edge of the tool. The fixture is fastened to each side of the grindstone trough by the bolts *F* and a series of bolt holes is drilled through each flange of the trough so that the jig may be moved in as the wheel is worn down. With this attachment the writer has ground trimming knives as accurately as could have been done on a special emery grinder.



JIG FOR DRILLING COLLARS.

C. H. Rowe, Lynn, Mass., sends the sketch of a jig which he has used with much satisfaction for drilling setscrew holes in collars. The collar *C* is held in position by means of the three locating pins *D*, *D*, *D*, and the swinging clamp *E*. In order to place a collar in position for drilling, the strap is swung to one side about the hand screw *G*. When the collar has been put in place the clamp is swung back and in doing so its motion is limited by the pin *F*, which brings it to a stop directly over the collar. At the top of the jig is a bushing *B* through which the drill is guided. When the outside diameter of the collars is likely to vary, the pins *D*, *D*, *D*, may be replaced by a central pin, *L*, Fig. 2, and the collar held on this while it is being drilled.



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The great Forth cantilever bridge in Scotland with its two spans of 1,710 feet each, has the longest single spans in the world. It is one of the world's long bridges, being 9,000 feet long. The Tay bridge is the longest great bridge, having a total length of 10,780 and following that is the Ohio River bridge at Cairo, Ill., with a total length of 10,560 feet. The new Manhattan bridge now building across the East River will come next with a length of 9,230 feet. The distinction of having the longest span will soon be taken from the Forth bridge, however. A bridge is to be constructed across the Strait of Canso between the mainland of Nova Scotia and Cape Breton, which will have a clear span of 1,800 feet. Its estimated cost is $5,000,000.

DIFFERENTIAL INDEXING.

METHOD OF INDEXING EMPLOYED ON BROWN & SHARPE MFG. CO.'S UNIVERSAL MILLING MACHINES.

This method of indexing is much simpler than the compound method heretofore employed for obtaining divisions that are prime numbers and others not obtainable with the regular index plates. The indexing is obtained in the same manner as for plain indexing excepting that the spiral head spindle is geared to the index plate. It differs from compound indexing in that the movement of the crank at each indexing is positively modified by the plate, which is geared to the spiral head spindle and moves whenever the crank is moved. The differential motion is thus obtained, allowing the indexing to be made with one circle of holes and the index crank turned in one direction the same as in plain indexing. This enables spacings to be made that cannot be obtained with an index plate locked in the usual way with the stop pin. In the compound method, it is necessary to exercise great care, as two circles are employed and it must be constantly kept in mind as to the direction in which the crank is to be moved, right or left. In the differential method, however, there is little opportunity for error, as the index crank is moved the same as in plain indexing, it being only necessary to place the proper gears in position, as indicated by the table which accompanies the machine. This table is made up to include both plain and differential indexing and avoids the necessity of two separate circles. It gives all divisions from 1 to 360 and the proper change gears and instructions as to placing them.*

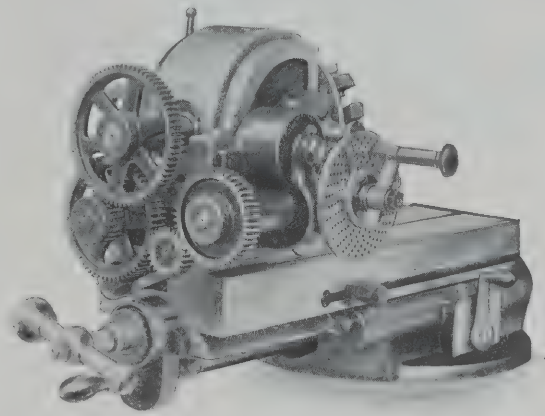
Fig. 1. Indexing for 319 Divisions.

As an illustration of the principle of the differential method of indexing, assume the index plate and spindle to be geared together in the ratio of one to one. The plate will then turn once while the spindle turns once. Therefore, if the plate turns in the same direction as the crank, and the crank is turned enough more than a complete revolution at each indexing to have the crank pin go into the same index plate hole, it will be readily seen that one turn of the crank will be in consequence of having followed the plate while the spindle has made one turn. Hence, the worm will have turned 40 turns in 39 indexings, which is equivalent to obtaining 39 divisions with equal gears and using only one hole in the index plate, the regular spacing number being 40 turns of the worm to one of the spindle. If the regular spacing number were 60, it would be possible to obtain 59 divisions with the equal gears.

The use of two idlers with the equal gears will rotate the index plate in an opposite direction to the crank. In this case, the crank, in making 40 complete revolutions, will meet the same hole in the index plate 41 times, thus obtaining 41 divisions by bringing the crank to the same hole in the plate at each indexing. It will, therefore, be readily seen that with only one hole in an index plate, it is possible, by gearing the index plate to the spindle in a ratio of one to one, to obtain 39 divisions with one idler and 41 with two idlers. With one idler, the spacing number is changed to 39 and it is possible to obtain divisions equal to 3 x 39 with a circle of 3 holes, or 4 x 39 with a circle of 4 holes, etc. With the same gearing and two idlers, the spacing number is changed to 41. Any division not obtainable with the index plate can, therefore, be made up with proper gearing.

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* This table is reproduced in the data sheet accompanying the Engineering Edition of this month.—EDITOR.

To explain this method further, the following examples are given:

Required: 59 divisions, no index plate with 59 hole circle being at hand. First, set the indexing for 60 divisions, which is 2-3 turn of the crank at every indexing. With 59 indexings, therefore, there will be obtained 39 1-3 revolutions of the worm, lacking 2-3 turn of the 40 required for one complete revolution of the spindle. With the proper gearing, 2-3 turn can be made up, the gears in this case being 48 on the worm and 32 on the spindle, with one idler. This will give the 59 divisions required, or with two idlers, 61 divisions can be obtained.

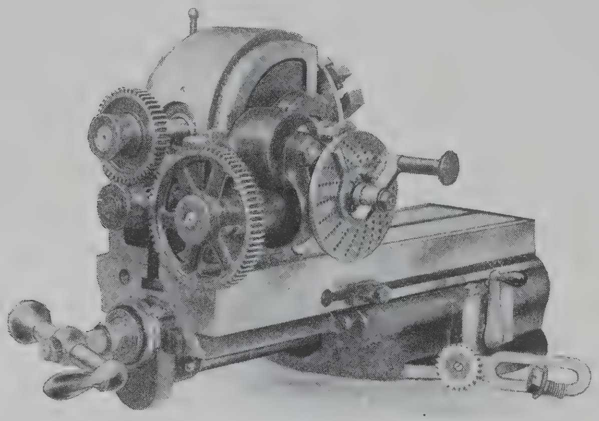


Fig. 2. Indexing for 177 Divisions.

In gearing the index plate to the work spindle, it is necessary sometimes to employ compound gearing, Fig. 1. As an illustration of this method of gearing, take 319 as the number of divisions required. First, select some number of divisions that can be obtained with any index plate furnished with machine; for example, 290, which would require a plate with 29 hole circle, using 4 holes at each indexing, 4/29 turn of the index crank. Indexing 319 times, 4/29, the worm will be turned 44 times, this being 4 turns more than the 40 required for one complete revolution of the spindle. 4 = the number of turns that the plate should make to one turn of the spindle. It can be expressed in the form, $\frac{3 \times 4}{1 \times 3}$; and multiplying the first turn, $\frac{3}{1} \times \frac{24}{24}$, and the second, $\frac{4}{3} \times \frac{16}{16}$, the expression becomes $\frac{72 \times 64}{24 \times 48}$. The terms of this fraction represent the teeth of available gears, the gears, 72 and 64, being drivers, 24 and 48 driven gears. The proper arrangement of these gears is found by referring to the table. Gear on spindle, driver; gear on worm, driven, or the follower. The first gear on the stud is a driver, which drives the worm gear. The second gear on the stud is a follower, being driven by the spindle gear. A collar is provided for use on the spindle to locate spindle gear. In some arrangements of the gearing, this collar is placed outside of the gear next to the nut and in others, back of the gear. For example: in compound gearing, it is placed back of the gear, bringing the gear out against the nut; and in simple gearing, many times it is necessary to place this collar back of the gear, for the reason that the gear may be so large that it will interfere with the gear of the worm sleeve. An example of this is shown in the gearing for 176 teeth. In this case there are two 24 tooth gears on the stud, making the gearing appear as if it were compound; but the two 24 tooth gears really act as a single idler, as they are on the same stud.

Spacing for One-Quarter Degree.—To space for ¼ deg., or 1,440 divisions, first try an indexing of 1/33, which will give a spacing of 1,320. It is sometimes found convenient to multiply the difference between the spacing required and the assumed number of spaces by the assumed indexing, which gives the gear ratio direct. Thus, the difference between 1,440 and 1,320 is 120, which, multiplied by 1/33, equals $\frac{120}{33}$ the required gear ratio; that is, there are 120 spaces to gain. One spacing being 1/33 of a turn of the index crank and 120 spacings required, $\frac{120}{33}$ is the number of turns of the index crank to one turn of the spindle. $\frac{120}{33}$ equals $\frac{40}{11}$. In order to express this ratio in a form that will permit the use of available gears, it is necessary to reduce it as follows: $\frac{40}{11}$ equals $\frac{200}{55}$, which can be compounded into $\frac{8 \times 25}{5 \times 11}$. Multiplying the first term, $\frac{8}{5} \times \frac{8}{8}$, the result is $\frac{64}{40}$; and the second term, $\frac{25}{11} \times \frac{4}{4} = \frac{100}{44}$; and the ratio, or train of gears, becomes $\frac{64 \times 100}{40 \times 44}$. In order to gain the required number of indexings, one idler is required to reverse the index plate in relation to the movement of the crank, which, combined with the compound gear stud, gives the effect of two idlers, for the reason that the gears on the stud act as one idler. The gears, 64 and 100, are drivers, and those with 40 and 44 teeth respectively are followers.

Fractional Spacing.—As illustrating this application, assume that it is required to space a Vernier to read to 1-12 of a degree or 5 minutes; the Vernier to be used in connection with a scale divided to degrees. Usually the method adopted to accomplish this is to have the Vernier spaces occupy a distance corresponding to 11 degrees and to divide this into 12 parts or spaces, which may be expressed as follows:

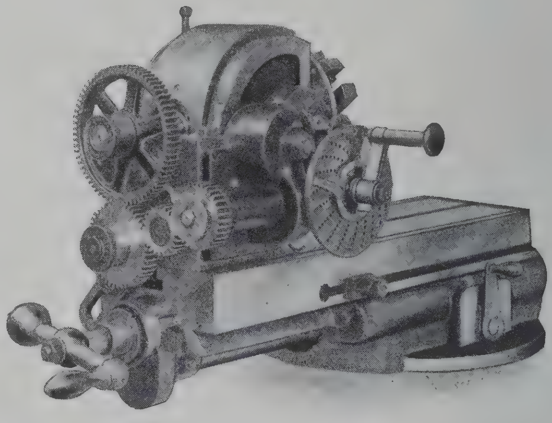


Fig. 3. Indexing for 169 Divisions.

$\frac{11}{360} \div 12 = \frac{11}{4320}$, which is equal to one space. There would, therefore, be $\frac{4320}{11}$ spaces in the whole circle, or 392 8-11 divisions. Indexing of 1/9 or 360 gives the difference between 392 8-11 and 360 or 32 8-11 indexings to be obtained with the gearing. 32 8-11 $= \frac{360}{11}$ indexings, which, multiplied by the value of one indexing, 1/9, gives $\frac{360}{11} \times \frac{1}{9} = \frac{40}{11}$, the resulting gears will be $\frac{200}{55}$ or $\frac{64 \times 100}{40 \times 44}$, one idler being required. It will be noted that the gears called for in this example are the same as those used in the one just previous.

This method of indexing has been applied to all of their universal milling machines by the Brown & Sharpe Mfg. Co., to whom we are indebted for the above description and photographs.

ITEMS OF MECHANICAL INTEREST.

Stud Setter—Cutting Odd Worms—High Pressure Piston Packing—Magnetic Attachment for T-square and Drawing Board—Spindle Boring Machine.

STUD SETTER AND EXTRACTOR.

An English stud setter and extractor of somewhat novel construction was described in a recent issue of the *Mechanical World*. It can be used both for setting studs and for removing them. Broken studs can be removed provided 5-16-inch grip is available. This, of course, applies only when the studs are not "seized" or rusted fast, but are merely broken off in such way that a grip cannot be taken with ordinary tools. A socket *A*, provided with a square *E* to take a tap wrench, is placed over the stud to be removed. The sliding wedges *B B* are then pressed in equally until their serrated edges are in contact with the stud, when by turning the tool by the aid of a wrench the stud is extracted. The stud is removed either by a pipe wrench, or by placing it in the vise and turning the tool in the reverse direction. To change the tool to a stud fixer, the coverplate *C* is removed, the pins *D*, *D*, which are loose in the wedges, pressed through to the other side, the wedges inserted in the reverse position, and the coverplate replaced.

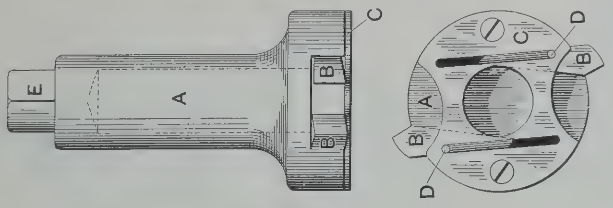


Fig. 1. Device for Setting and Extracting Studs.

METHOD OF CUTTING WORM OF ODD PITCH.

Under the heading "Workshop Practice" in a recent issue of *Feilden's Magazine* a description is given of the method followed in replacing a worm when it was found there were no change gears to the lathe that would permit its being cut. The new worm casting was bored and keyed on a mandrel along with the old worm. A double-ended toolholder was clamped to the cross slide of the lathe. Into the left end was fitted a cutter for chasing the new worm and into the other end was fitted a steel guide filed to fit the old worm, the idea being to make the old worm give the necessary traverse to the lathe carriage for cutting the new worm. All this is clear in the accompanying cut. The steel guide projected ¼-inch further than the cutter when starting the cut; as the successive cuts were taken, the cutter was advanced in the toolholder without moving the cross slide.

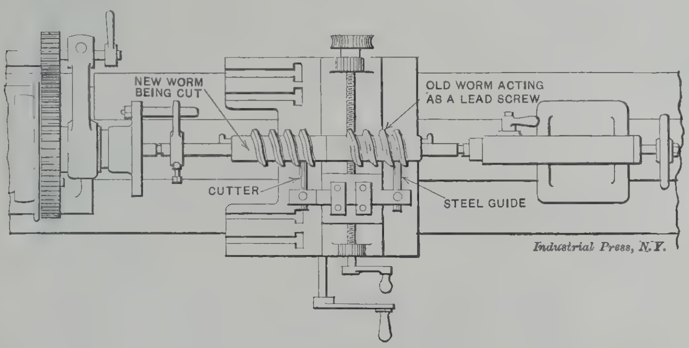


Fig. 2. Cutting Worm of Odd Pitch.

HIGH-PRESSURE PISTON PACKING OF ENGLISH DESIGN

Apropros of the articles that appeared on pistons and packing rings in the July and December, 1902, issues, we reproduce from London *Engineering* a short description of Downie's piston packing for high-pressure steam engines, which is in use in some large marine engines, both for the main pistons and for the piston valves. The packing consists of two rings placed side by side in one groove, which is turned wider at the bottom than at the top. The rings are faced flat on their opposing faces and conical on the piston and junk-ring faces. They are cut and sprung into place so as to "break joints." The object of the inclined upper and lower faces is to prevent undue pressure on the cylinder walls because of the steam pressure. By regulating the distance between the junk-ring and the piston, the diameter to which the rings can expand can be controlled. In fitting the rings a little slack is allowed so as to let the rings wear to the cylinder, after which it is claimed they remain tight, the slight wear that takes place on the conical surfaces being sufficient to keep them full bore. The grooves shown in the sides of the rings, are evidently for "water packing."

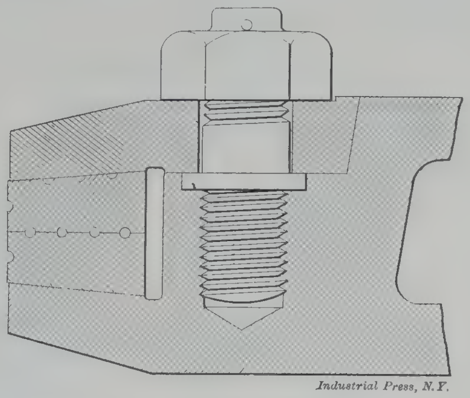


Fig. 3. Piston Packing Ring for High Pressures.

DRAWING BOARD AND T-SQUARE WITH MAGNETIC ATTACHMENT.

An English novelty in drafting room appliances, is a T-square having a number of small horseshoe magnets mounted in the head and so arranged that their poles come in contact with an iron strip attached to the left-hand end of the board, the idea being to hold the T-square to its right-angle position, by magnetic attraction alone. This, of course, allows the draftsman to use both hands at his work more advantageously. The magnets are said to oppose little resistance to movement of the blade to any position parallel with its normal position, but considerable force is required to displace the blade from its right-angle position. A drawing board with this attachment may be used in a vertical, sloping or horizontal position with equal facility.

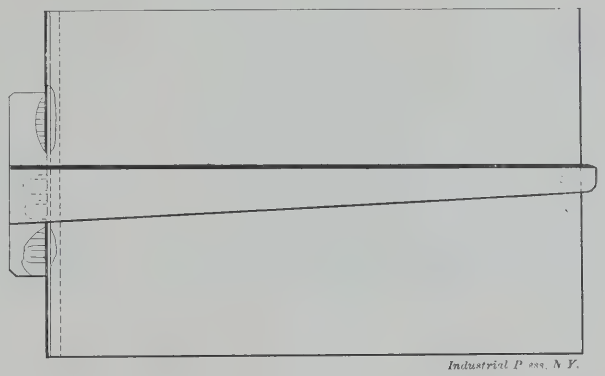


Fig. 4. Drawing Board and T-square with Magnetic Attachment.

STENCILING COUNTERSHAFT SPEEDS.

Extensive additions are being made to the Juniata Shops of the Pennsylvania R. R., at Altoona, Pa., and many new machines are being installed. Mr. A. Timm, general foreman of the machine shop, writes us that they have been considerably troubled by the neglect of machinery houses to give the speeds at which the countershafts for various machines received from them, should run. The machines received direct from the manufacturers, are usually accompanied by a blueprint or letter giving the proper countershaft speed, and the same information is sometimes given in their catalogues. But the machinery received at these shops from machinery houses, has, in all cases, lacked this quite necessary information. Eight small machines were received from one house in one week, and not one of them was accompanied by the countershaft speed. Of course it is a simple matter to calculate the countershaft speed when the spindle speeds are known, but this all takes time and is entirely unnecessary labor. Mr. Timm suggests that machinery builders generally adopt the practice of stenciling, on the countershaft for each machine, the proper speed at which it is to run. This should make a record of sufficient permanence to insure its reaching the customer, even if the machine has passed through a machinery house.

A MONSTER LEATHER BELT.

An exceptionally large leather belt has been put into place at the power house of the Twin City Rapid Transit Co., at Minneapolis. It was supplied by the W. S. Nott Rubber Company of that city. The belt is 100 feet long, weighs 2,000 pounds, is 80 inches in width and three-ply. There are eight hides to every four feet of the belt, which means that 200 head of cattle—a respectable herd for a small stock farmer—were required to furnish enough leather for this enormous belt.

Throughout the entire process of construction no fasteners of any description were used outside of a special belt cement of high adhesive power. Altogether it took 15 men more than a month to fashion it. The size of the belt gives an idea of the diameter of the big wheel which will before long be furnishing much of the street railway motive power. The largest belt ever built by this company was furnished to the Anaconda copper mine at Anaconda, Mont. It was 180 feet long, 66 inches in width and four-ply. It required 360 hides and weighed 3,600 pounds, driving from a 28-foot diameter pulley to an 87-inch driving pulley. Its speed was 5,000 feet per minute, and it transmitted an average load of 1,800 horse power.—*The Age of Steel.*

* * *

A SPINDLE BORING MACHINE.

Of the different problems with which the machine tool builder is confronted probably none have required more careful attention and experiment than that of boring out the hollow steel spindles used on lathes, boring machines, etc. For this purpose many of the different builders have designed and built their own machines, which are generally admirably adapted to the class of work they are to handle. The photograph illustrates one of these spindle boring machines which has lately been built by the Springfield Machine Tool Co., Springfield, Ohio, for their own use. The construction of the head of this machine is clearly shown in the drawing Fig. 6.

This machine is intended to bore holes from 1 inch to 6 inches in diameter in spindles varying from 1½ inch to 7 inches in diameter. The cone is keyed to a spindle which is geared into the main spindle of the lathe with a ratio of three to one. Back gears are provided so as to give eight different speeds, arranged in geometrical progression.

The most important requisite of a spindle boring machine is a wide range of feeds of ample power. The feed power is taken from the coneshaft and transmitted to a cone the shaft of which is geared into the feed rod. In addition to the use of a five-step feed cone, back gears are furnished so that ten different rates of feed are obtainable, giving a range from .0005 inch to .01 inch per revolution of spindle. Motion from the feed rod is transmitted to the carriage by means of a train of gearing and a pair of rack pinions which engage in a pair of steel racks, one of each being located on the top of the bed and at the side of the V's, upon which the carriage travels. This arrangement makes a much steadier feed than could be obtained if only one rack were used, as is customary in engine lathe construction. The feed is engaged or disengaged by means of a powerful friction which is so designed that it will slip should any unusual resistance be encountered. A pilot wheel, keyed to a rack gear shaft provides for a quick return of the carriage.

A duplex single-acting pump supplies a constant stream of oil, which is essential to the proper working of the drill.

As will be noted the spindle of the machine is hollow, which permits of holding the spindles to be bored, at one end with the universal chuck and at the other end with suitable collars which must fit the ends of the spindle that is being bored and the bore of the machine spindle. This construction enables a comparatively short machine to be used for boring long spindles, whereas if one end of the spindle were to be held in the chuck and the other end in a bearing or steady rest, the length of this machine would require to be almost doubled. A rest is provided which guides the boring tool at the commencement of the cut and after a hole has been drilled a short distance, say 2 inches or 3 inches, it may be removed by being swung out of position.

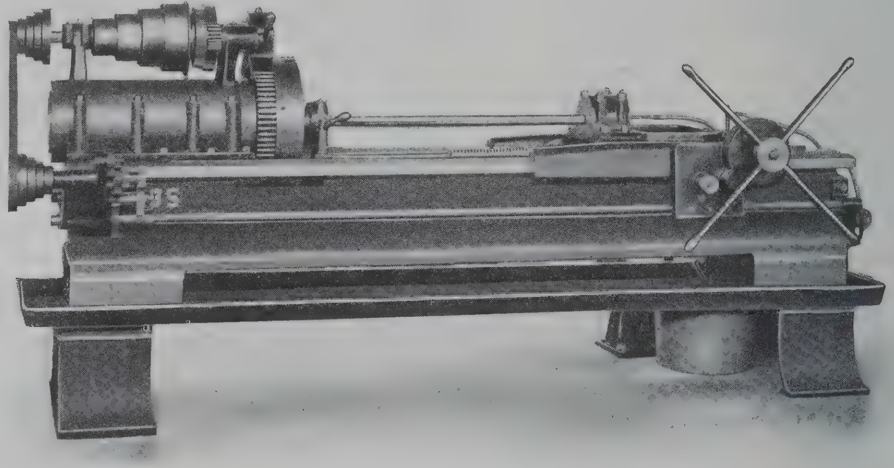


Fig. 5. Machine for Boring Spindles.

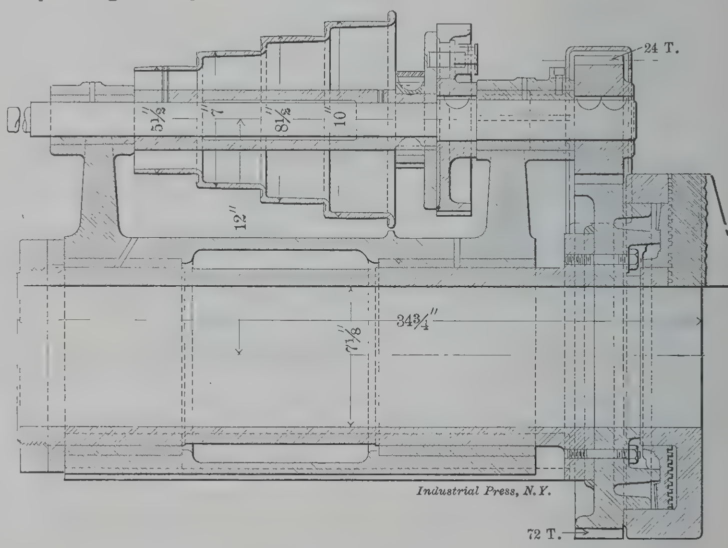


Fig. 6. Section through Head of Spindle Boring Machine.

The carriage has a travel of 5 feet, and therefore, permits of boring a hole 5 feet in length without re-setting the boring bar, and as ample provision is made for this purpose, it is possible to bore holes 7 feet or 8 feet in length without turning them end for end.

* * *

According to a short article recently published in the *Electrical World and Engineer* the thawing of frozen water pipes appears to be a regular winter industry in Sault Ste. Marie. A transformer is mounted on a sleigh and hauled around town to wherever frozen pipes may be. Connection is made to the pipes each side of the frozen section with the secondary wires from the transformer and the primary wires are connected to the 2,200 volt circuit, through a water rheostat. The water generally begins to flow very quickly after the current is turned on, usually within one minute. Pipes as large as 4 inches diameter and frozen more or less for 200 feet, have been thawed out in this manner and at a fraction of the cost of following the usual plan of digging. That the business is profitable may be inferred from the usual charge being about $3.00 for thawing house pipes.

A FORTY-FOUR FOOT PIT LATHE.

DESCRIPTION OF LARGE FRICTION DRIVEN LATHE.

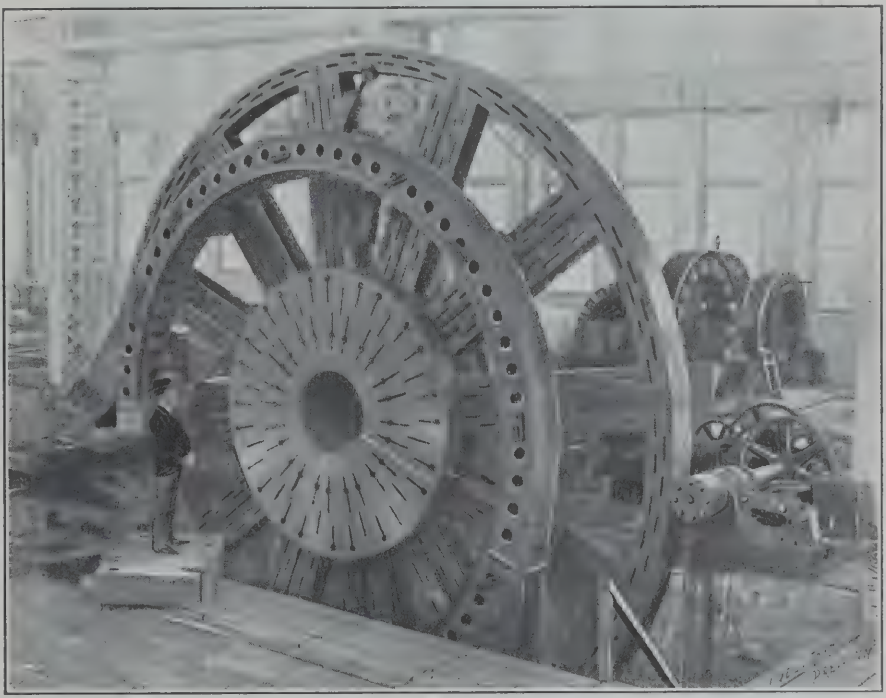
Paper read before the American Society of Mechanical Engineers, December, 1902, by John M. Barnay.

The machine here illustrated was designed to meet the demands of an establishment manufacturing the heaviest type of electrical machinery. The ever-increasing dimensions of this class of machinery make it particularly desirable that the existing heavy machine tools should be capable of extension of capacity with a view to probable future requirements; and that a pit lathe is peculiarly adapted to such extension will, doubtless, be readily admitted.

The faceplate of this lathe measures 30 feet in diameter, and the present dimensions of the pit will admit of swinging 44 feet on centers, with a maximum width of 12 feet. The large faceplate is built up of twelve segments. The rim is of box section, the ends of the rim in each section being finished to make the joint, and the segments being held together at the rim by body-bound bolts. The arms are slotted for bolts, and the space between segments is also shaped to receive the usual square-headed bolts, as the inner end of each segment is fastened to the smaller faceplate by several body-bound bolts. The smaller faceplate is cast integral with the forward section of the spindle which revolves in a babbitted bearing 48 inches in diameter by 68 inches in length, the rear bearing being 22 inches in diameter and 28 inches long. It is calculated that the pressure on the main bearing will, at times, attain a maximum of 125 pounds per square inch.

Teeth were cast into the periphery of the 12-foot faceplate for the purpose of driving same while turning out the spindle bearing. After the spindle was finished by this method the segments of the large faceplate were bolted on, the spindle assembled on the headstock, and the periphery of the 30-foot faceplate turned off, with the spindle in its own bearing.

A novel feature of interest in connection with this machine is the method of drive adopted, which is a friction roller, 18 inches in diameter, made of compressed paper, while the rim of the large faceplate, 15 inches wide, affords the necessary contact surface for driving. Power is supplied by a 75 horse power motor, quadruple geared, the use of the multiple voltage system giving the machine a range covering all diameters from six feet to the present capacity, though the gear train is designed to admit of two changes of back gear in addition.



Friction-driven Pit Lathe.

The tool carriages are supported on massive cast-iron columns resting on the bottom of the pit, and the feed mechanism is driven by an independent motor properly back geared. By the use of the multiple-voltage controller, and a device called a feed regulator, at rate of feed from 3-64 inch to 2¾ inches per minute can be had without a change of back gears. There was also designed for this machine an outboard bearing to support the outer end of mandrels and boring bars which is provided with a geared sleeve connected to a train of back gears driven by an independent motor; the whole being self-contained and constituting a portable boring and facing tool. An approximation of the total amount of cast iron used in the construction of this machine places the weight at 480,000 pounds, of which the spindle and two faceplates together weigh about 155,000 pounds.

As would be expected in this class of tool, the center of gravity of the revolving parts lies very close to the edge of the pit; hence, the matter of a substantial foundation became one of considerable importance, and to meet the severe requirements the design of the headstock provides a large area for the distribution of this pressure, so that the forward part of the headstock alone covers an area of 68 square feet. The masonry foundation consists of a layer of best Portland cement grouting on top, surmounted by a five-foot layer of vitrified brick which, in turn, rests on a massive column of best pressed brick, all laid in first quality of Portland cement.

[In connection with the above-described machine Mr. Barnay furnishes us the following data regarding the power required for operating and the power transmitted by the friction wheel.—Editor.]

The weight of the revolving parts of the pit lathe alone is about 155,000 pounds. Add to this the weight of the casting bolted to the faceplate and we have 210,000 pounds. The diameter of the main bearing of the spindle equals 48 inches. The number of revolutions of the spindle during the operation of boring was ¾ revolution per minute, representing a cutting speed of 45 feet per minute. Assuming a coefficient of friction of 0.10 for the bearings, we have power required to drive machine with casting bolted to faceplate, but without cut,

$$\frac{210{,}000 \times 48 \times 3.1416 \times .10}{12 \times 33{,}000}$$

equals 8 horse power, nearly. To this is to be added the power required to run three cuts each ¾ inch deep with ⅛ inch feed. At forty-five feet per minute cutting speed this is equivalent to removing 64¼ cubic inches of metal per minute. Assuming that it takes 35-100 horse power to remove one cubic inch of cast iron per minute, a good average, as established by numerous independent tests, we have power required to take three cuts as above, about 22½ horse power.

Then 8 plus 22½ equals 30½ horse power, which is the total horse power transmitted by the friction wheel at the surface speed of 74¼ feet per minute.

Now let us compare this result with such published formulæ as have been found available on this subject. Taking, for instance, Prof. Goss' formula published in the transactions, A. S. M. E., XVIII, pp. 102. According to this formula horse power equals .000238 D. W. N., in which D equals diameter of wheel in inches; W equals width of wheel in inches; N equals number of revolutions per minute.

Applying this to our case, we have, D equals 18; W equals 15; N equals 15¾; .000238 D. W. N. equals 1.012 horse power.

As Prof. Goss' formula is based on pressure of contact of 150 pounds per inch, it would follow that the pressure of contact in our case is 150 : X : : 1.012 : 30½, which gives 4,525 pounds.

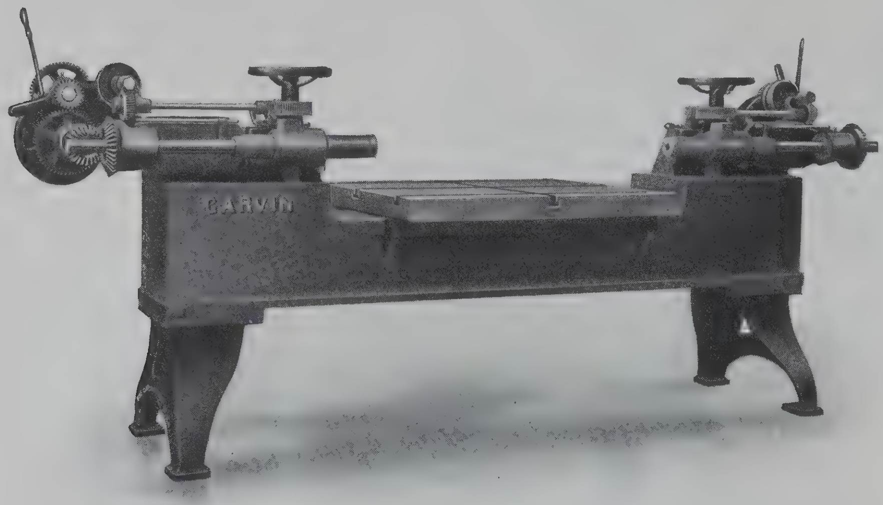
In justice to the author of the above formula it should be said that it was probably never intended to apply at such extremely low surface speeds. As stated in his paper, the experiments conducted at the time of the establishment of the formula covered surface speeds between 400 and 2,800 feet only.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

DUPLEX DRILL LATHE.

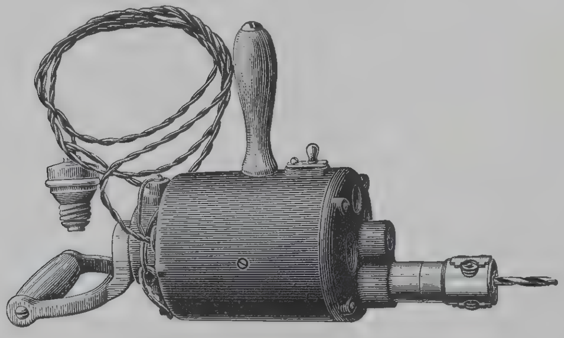
A special manufacturing tool that is simple in construction and well adapted to its work is shown in the accompanying half tone. This is a duplex drill lathe and is used for drilling, through jig eyes, such work as hinge holes in fire doors and their frames, sewing machine treadles, machine frames girths, etc. On either end of the lathe bed is mounted a drill spindle similar in construction and operation to that of an ordinary vertical drill. These spindles are independent, have a light, quick hand movement to and from the work and are provided with power feed and adjustable automatic trip. Each spindle is driven by a four step cone from an independent countershaft, and is back-geared, giving eight changes of speed. The work is held on a heavy T-slotted table on which are also placed the jig eyes and fixtures used for directing the drill. The table is of ample size for handling large work, while for drilling small pieces extension drills are used. In the machine illustrated the distance between the heads is 46¾ inches and the height of the center of spindles above the table is 5¼ inches. These dimensions may be altered to meet any desired requirements. This machine is the product of the Garvin Machine Co., New York.



Duplex Drill Lathe.

ELECTRICALLY DRIVEN HAND DRILL.

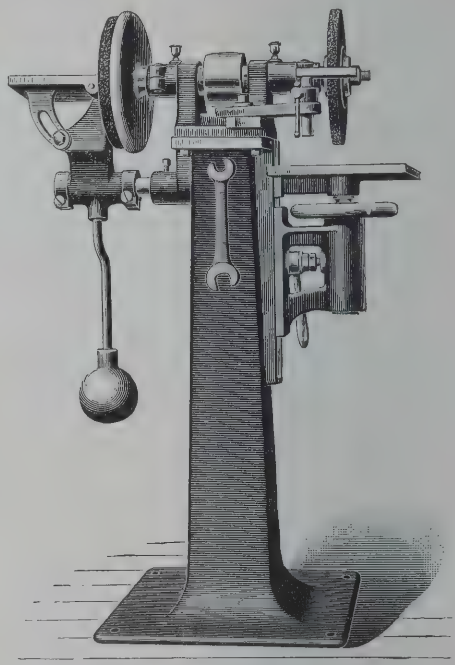
The portable electrically driven hand or breast drill here illustrated is likely to prove of great convenience in any shop where it is used to replace the ordinary hand drill. Owing to its greater speed it performs the work much more rapidly than it could be done by hand, besides saving the strength of the operator. The power is supplied by connecting the flexible wire cord to any convenient incandescent lamp socket, and the range of operation is limited only by the length of the cord. The drill is under perfect control at all times as a switch is provided, where it is within easy reach of the index finger, for starting or stopping the motor. This machine is made by the Hisey-Wolf Machine Co., Cincinnati, Ohio, and is supplied in three sizes, taking drills up to ¼ inch, ⅜ inch and ½ inch respectively.



Electrically Driven Hand Drill.

NEW END AND SURFACE GRINDER.

The illustration shows a grinder, for end and surface work, that is made by the Rowbottom Machine Co., Inc., Waterbury, Conn. This machine possesses features that make it especially helpful for tool and press room work and for a variety of purposes in manufacturing.



Combined End and Surface Grinder.

The table on the right is counterbalanced and provided with a quick method of adjustment for wide ranges by the lever shown under the table. By lifting up the lever the table is released and is free to move either up or down, by pressing the lever down the table bracket is firmly fastened to the column; the handwheel under the table is then available for fine feed. On the left is a swinging table for end grinding by swinging the work across the face of wheel; this table is adjustable for angular work and is provided with adjustment to keep it close to the wheel. The emery wheels for end grinding may be replaced by emery cloth disks or the machine can be provided with both, as the change is readily made from one to the other, thus allowing the machine to cover a large range of grinding. The bearings are dust proof with adjustment for taking up wear, and oiling devices are provided.

The emery wheels are 10 inches diameter and the emery cloth discs 12 inches diameter. The table for surface work is 16 inches long by 10 inches wide, with up and down adjustment of 8 inches and is capable of surfacing 8 inches wide.

LOWE TEST INDICATOR.

Fig. 1, on next page shows a test indicator that has been brought out by H. A. Lowe, Waltham, Mass., and which, owing to the convenience of its manipulation, will be found useful for an unlimited number of purposes in the machine shop.

The shank of this indicator is 7-16 inch by 15-16 inch and is carried in the tool post of the lathe. Being casehardened it is not injured by the tool post screw, and at the same time the channel shaped section of this shank affords protection to the delicate working parts.

The forward end of the holder terminates in a point bearing a pivot about which oscillates a lever the short arm of which is placed in contact with the work to be indicated. The long arm of this lever runs back to a spiral groove in the vertical pointer spindle. This arrangement causes the pointer to revolve over a horizontal graduated disk mounted on the back end of the holder. This disk is graduated to read in thousandths of an inch of movement of the short lever arm and the leverage is such that any movement of the short lever is multiplied one hundred times by the pointer. A flat spring, placed under the long arm of the indicator, keeps the pointer normally at the zero position. This tool may be applied to testing shafting, flanges, gears and all kinds of lathe work, and is also used in the planer and shaper for setting angle plates and work

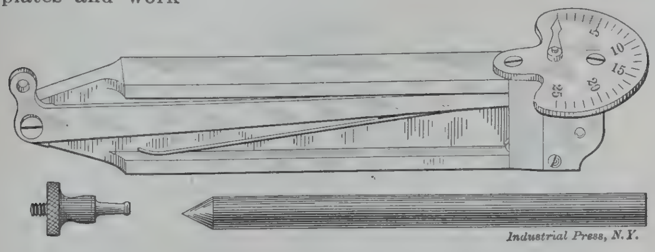


Fig. 1. H. A. Lowe's Test Indicator.

When the indicator is to be used for internal work the screw button, shown beside it in the cut, is inserted into the eye of the short arm and the point of this button is placed in contact with the inside of the hole. This is illustrated in Fig. 2, which shows the indicator in use for re-chucking a gear so that the hole will run perfectly true. The pointed rod, shown just below the indicator in Fig. 1, is used for "wiggling up" or locating work on the faceplate central to a prickpunch mark. One end of this is fitted with a female center which is placed on the tail center of the lathe while the point is placed in the prickpunch mark in the work which is held on the faceplate. Then by use of the indicator, as shown in Fig. 3, the work may be quickly brought to a central position on the faceplate.

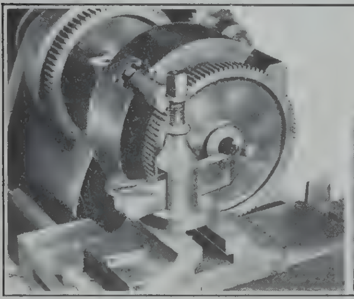


Fig. 2. Re-chucking Gear by Hole.

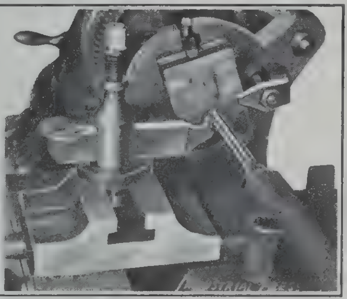
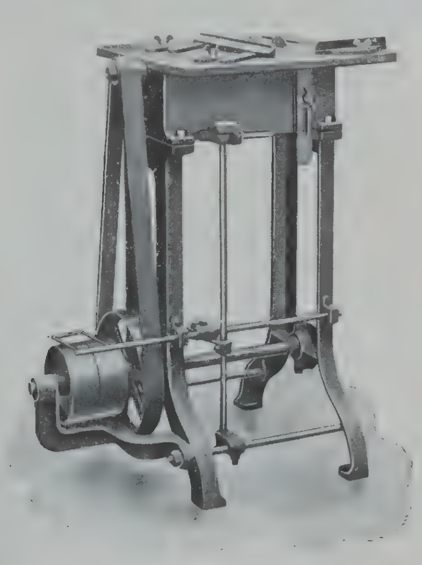


Fig. 3. Setting Jig on Faceplate.

THE ACME METAL SAW TABLE.



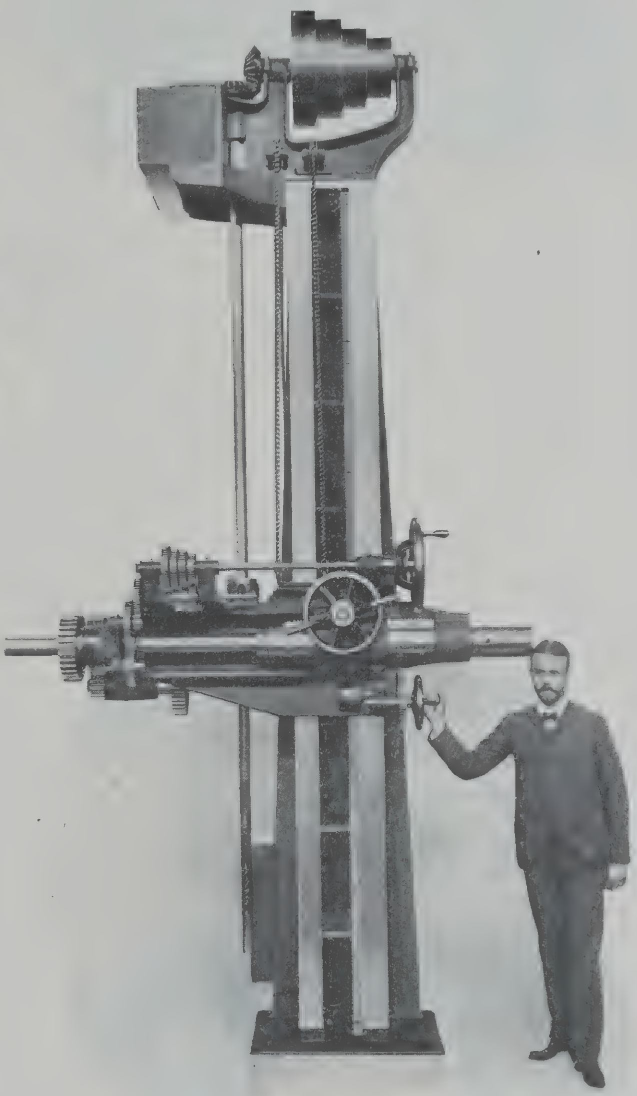
Acme Metal Saw Table.

This saw table is the invention of Mr. F. D. Hazelton and is being placed on the market by Hazelton and Donald, Philadelphia, Pa. The table is the result of the inventor's needs for a saw for cutting sheet, rod and tube brass, fiber, hard rubber, printers' furniture and electrotype plates. The machine occupies a floor space of but 18 x 24 inches, is constructed wholly of metal and is self-contained. One important feature is that the saw arbor is but one inch below the surface of the saw table, thus permitting the use of saws of small diameter and consequently obtaining the greatest power and accuracy. The table swings entirely open or may be set to saw any desired depth while the slitting gage may be adjusted for slitting any width up to 12 inches. The cross cut gage will swing either way to any practical angle. An improved device is provided for holding the arbor from turning while attaching or removing the saws. A removable throat plate allows the use of wood cutting saws up to 6 inches in diameter.

A DRILLING AND BORING TOOL FOR STEAM ENGINE WORK.

The accompanying half-tone illustrates an interesting special machine, for use on large steam engine work, that was recently built for the W. A. Harris Engine Co., Providence, R. I., by the Prentice Bros. Co., Worcester, Mass.

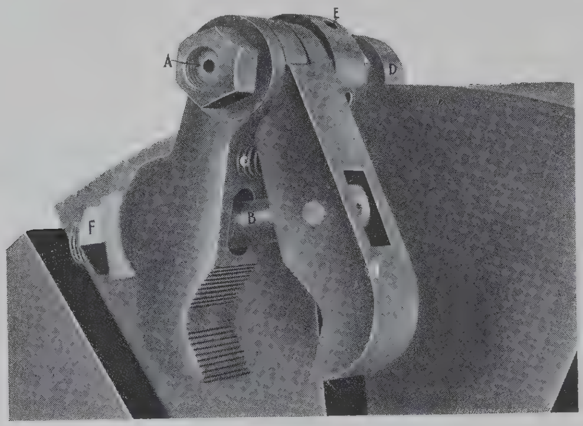
This machine was designed for boring up to 36 inches in diameter and is capable of drilling from the solid up to 6 inches. The base is bolted to a cement foundation while the top is of suitable shape to fasten to the overhead timbers of the shop. The total height of the machine from the base to the top of the cone pulley is 14 feet 4 inches. This allows the spindle to be raised to a maximum distance from the base of 10 feet 6 inches, or it may be lowered to a height of but 14 inches. The head is counterbalanced and its vertical movement in the upright is facilitated by the employment of compound gears. The spindle, which has a horizontal traverse of 23 inches, has four changes of geared feed, hand feed, and quick return motion. This machine can also be used for vertical milling, feeding by hand through the compound gearing.



Prentice Bros. Co.'s Special Drilling and Boring Machine.

A NEW LATHE DOG.

A new lathe dog which is manufactured by the Eddystone Engineering Works, Eddystone, Pa., is illustrated in the accompanying cut. This dog has two jaws which are pivoted about a central stud, *A*, and grasp the work in the open ends, A bolt, *B*, tightens the jaws onto the piece being turned and when this bolt is released the spring *C* spreads them apart and the work is at once released. The steel about which the jaws pivot has at its lower end a T-head *D* and clamping nut *E*, so that it can be firmly clamped at any point on the faceplate. In use, this stud is slid into one of the faceplate slots, as shown in the cut, and the jaws are brought down over the work, which is held on the lathe centers. The jaws are then tightened on the work by the nut *F* and the driving stud is clamped to the faceplate by a turn of the spanner nut *E*. This makes a rigid and powerful clamping dog which is easily operated. When removing the work and introducing new pieces, if they are of the same size, it is only necessary to operate the bolt that clamps and releases the jaws as the stud holds the dog in the proper position for receiving the pieces. This dog is made in four sizes capable of taking work from 1 inch to 12 inches in diameter.



New Lathe Dog.

SPECIAL GEAR CUTTERS.

R. M. Clough, Tolland, Conn., is making two forms of gear cutters, one of which, we believe, is distinctly new and the other is so little known that it will be of interest to most mechanics who may be more or less familiar with gear cutting. The first-mentioned cutter is that shown in Fig. 1. It is made with shoulders at the sides of the regular teeth, for the purpose of milling off the tops of the gear teeth as the cutting of the tooth spaces proceeds. This saves turning the blanks since the tops of the teeth are all milled to correct length at the same time that the tooth spaces are cut. These cutters are made eight in a set for each pitch to cut gears of the regular Brown & Sharpe involute tooth shape, from 12 teeth to a rack.

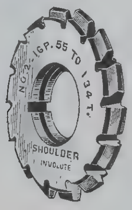


Fig. 1.

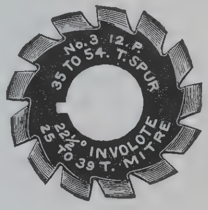


Fig. 2.

The cutter shown in Fig. 2 is for cutting bevel gears at one cut for each tooth which, of course, saves at least one and usually two cuts for each tooth, when done in the ordinary way. This cutter is, to all intents and purposes, a 22½ degree involute cutter, and is made eight cutters to a set for each pitch, for either spur or bevel gears. It is thinner on the points of the teeth than a Brown & Sharpe, or 15 degrees involute cutter, and is used by setting the gear at such an angle as to "shallow" the small ends of the tooth spaces the proper amount. The gears produced in this manner are said to run fully as well as when cut with three operations for each tooth, and the teeth are so shaped as to be somewhat stronger than the ordinary bevel tooth of the same pitch. Firms that are using these cutters prefer the gears to those cut in the ordinary way, to say nothing of the decreased cost.

AUTOMATIC GEAR AND RACK CUTTERS.

The Dwight Slate Co., Hartford, Conn., have recently redesigned and improved their gear and rack cutters in a manner tending to simplify their operation and increase the production. In their automatic gear cutters of earlier design it

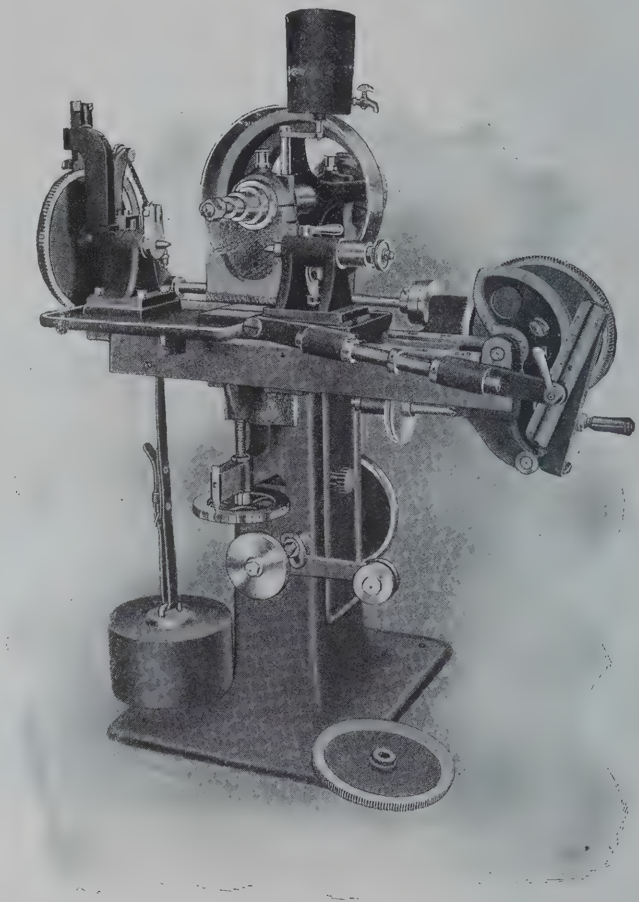


Fig. 1. Improved Automatic Gear Cutter.

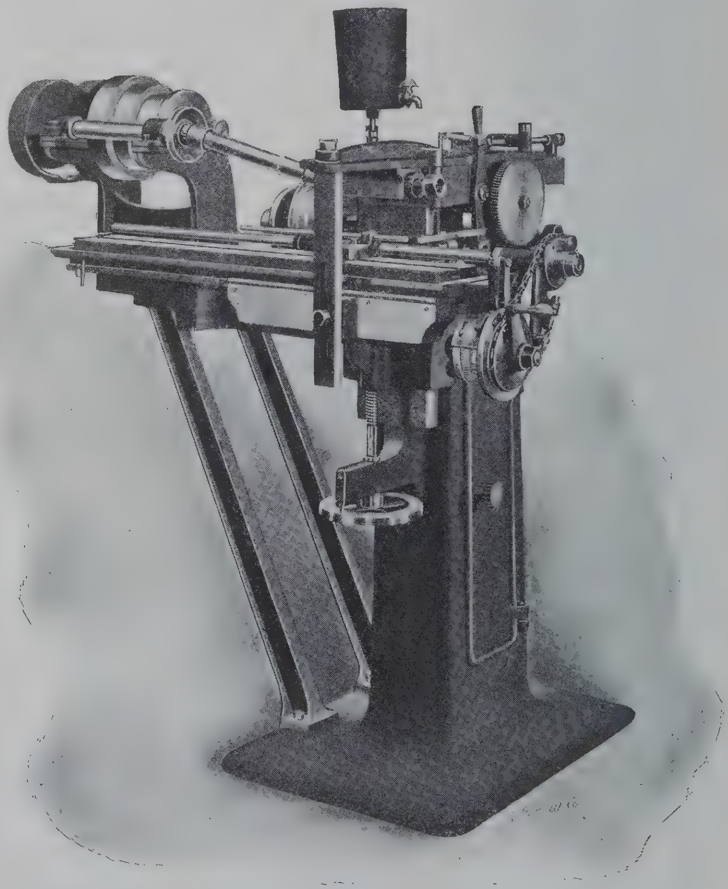


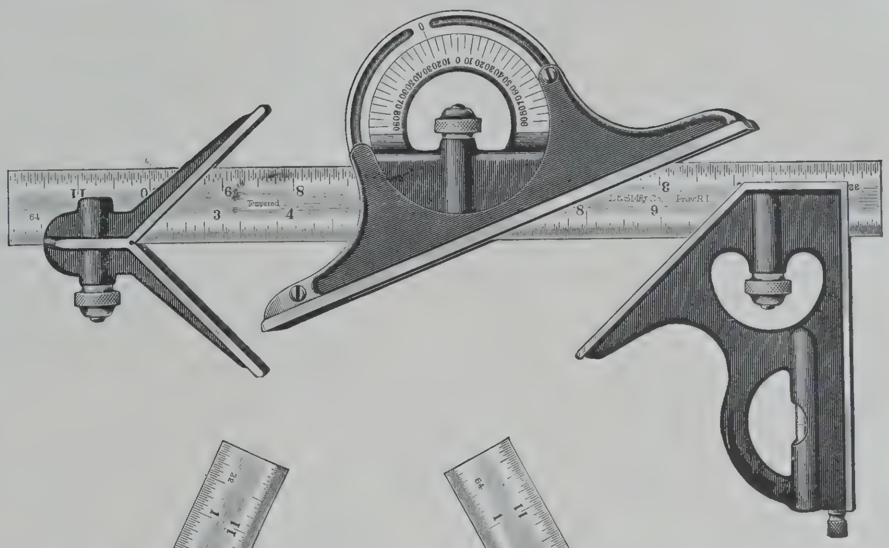
Fig. 2. Automatic Rack Cutter.

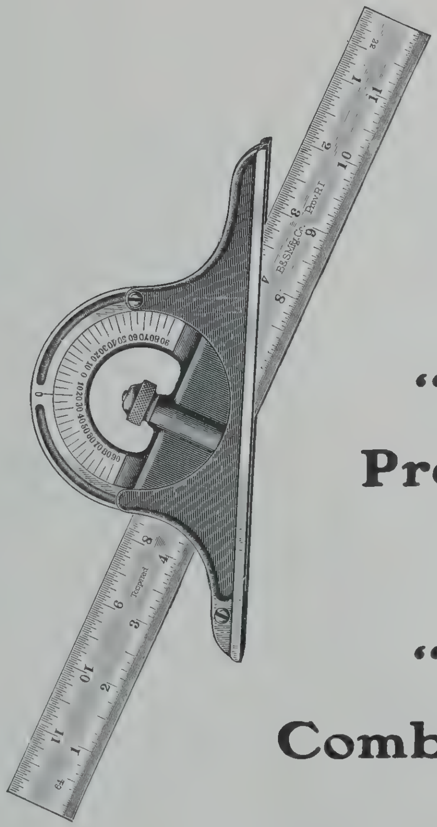
B·S **Brown & Sharpe Mfg. Co.** B·S

Providence, R. I., U. S. A.

NEW MECHANICAL MACHINISTS' TOOLS.

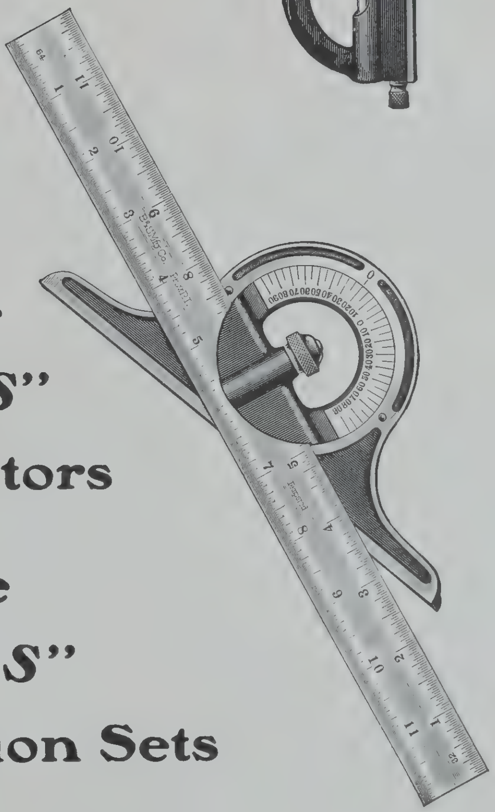
10 Different Styles.





The "B & S" Protractors

The "B & S" Combination Sets



POINTS OF SUPERIORITY—*Square Heads* of Steel, drop forged. *Clamping Groove* round, no sharp corners, forces blade against side of slot square with face of head. *Blades* accurately graduated, have shaded figures that are quickly read. *Protractor Heads* engine divided to 90 degrees either side of zero; Level furnished with head, accurately set parallel to face. **ALL PARTS INTERCHANGEABLE.**

B·S **A Convenience**—Our tools carried in stock by hardware dealers. B·S

CATALOGUE NO. 103 MAILED TO ANY ADDRESS.

was necessary to change the cams that regulated the length of the cut, three cams being required for each machine. In the new machines one cam only is used and this, in connection with the oscillating arm, can be readily adjusted to give any required length of cut within the capacity of the machine. In operation the arbor, carrying as many blanks as can conveniently be placed thereon, is put on the centers and the machine started. Once put in motion, the cutting will continue until the completion of the last tooth, when the feed motion will be tripped out of engagement. After the completion of each cut the table is returned to first position automatically and at the same time the index is unlocked, moved to the proper spacing and securely relocked. Fig. 1 illustrates the No. 2 machine which is capable of cutting gears of 6 pitch and finer up to 8 inches in diameter; extreme length of cut 4 inches. The No. 1 machine cuts gears of 12 pitch and finer up to 4 inches in diameter; extreme length of cut 3 inches.

The new rack cutter is shown in Fig. 2. This machine as formerly built was semi-automatic, the operator being required, after each tooth was cut, to feed the head back by hand and space for the next tooth. It has now been made into a full automatic cutter and when the work is once started it will continue without attention, until the entire rack is cut. This machine will cut racks of 12 pitch or finer, 19 inches long at a single setting, while by resetting any length of rack may be cut.

THE NEW YORK NATIONAL EXCHANGE BANK.

The New York National Exchange Bank, corner of Chambers Street and West Broadway, has just completed a number of improvements and additions which greatly increase its facilities for doing business, and a happy combination of practical experience and good taste has combined not only to utilize every foot of space, but to decorate the new banking rooms so that they equal in attractiveness any in New York—a comparison not to be lightly made.

The screen work forming the partitions is constructed of Pavanozza marble up to the counter level, above which the partitions or cages are constructed in bronze metal finished in verde antique, the interiors being fitted with latest improved counter systems including filing cases of all kinds. The wood work and furniture are of Mexican mahogany and walls finished with green burlap which makes a pleasing contrast with the other fittings. The vaults are constructed with heavy steel linings, inside and outside vestibule doors, and the reserve fund is further protected by being contained in two massive chests of the heaviest construction; the whole controlled by time and combination locks of the latest design.

The New York National Exchange is an old and well-known bank, organized in 1851, and for many years conducted on what may be termed old-fashioned methods; until, about three years ago the management was undertaken by younger and more active men, who have increased its business and resources with such rapidity as to attract the attention of the down town business community. During the period referred to the total resources have moved up from about $2,000,000 to over $7,000,000. The officers of this institution are James Rowland, president; Lewis E. Pierson, vice-president; and Rollin P. Grant, cashier.

* * *

FRESH FROM THE PRESS.

Dies: Their Construction and Use. By Joseph V. Woodworth. Published by Norman W. Henley & Co., 132 Nassau St., New York. 384 8vo. pages. Illustrated. Price, $3.00.

This book treats of tools for sheet metal working. Its pages contain descriptions, with illustrations, of dies, press fixtures and sheet metal-working devices, from the simplest to the most intricate, and the author has described their construction in a clear manner, so that any good mechanic will understand how to design, construct and use them. Mr. Woodworth is a practical toolmaker and diemaker and has become well known through frequent contributions to Machinery and other technical papers, and his book on dies is the outcome of his work in this direction. Its various pages contain the articles that he has contributed to the different papers, thoroughly revised, and re-written where necessary, with a great deal of additional matter. The volume is largely the result of Mr. Woodworth's own experience, supplemented by material gathered through observation in different metal-working establishments.

There are twelve chapters in the book, as follows: Single or blanking dies, and double or piercing and blanking dies; simple dies for use in machine shops; gang and follow dies; the adaptation and use of simple dies and press fixtures; bending and forming dies; perforating dies; curling, wiring and seaming processes; drawing processes, for sheet-metal shells; coining processes—operations on heavy stock; feeding sheet metal to the dies; annealing, hardening and tempering—the use of files; miscellaneous dies, presses and fixtures.

This is the most elaborate treatise that has appeared on sheet metal work, and there is probably not a diemaker or a toolmaker who would not find some information of value within its pages. There are over 500 illustrations, most of which are wax engravings made from original drawings by Mr. Woodworth. The development of sheet metal working has been so rapid during the past few years that most mechanics have not had the opportunity to keep pace with the construction of the tools used in such work and the author has done well to gather together so large a fund of information upon the subject, where it may be readily referred to.

ADVERTISING LITERATURE.

The Grant Gear Works, Boston, Mass. Circular and price list of machine chains and sprockets.

The Joseph Dixon Crucible Co., Jersey City, N. J. Booklet descriptive of graphite facings for flat molding and stove plates, for dry sand work, for green sand, etc.

The Garvin Machine Co., Spring and Varick Sts., New York. General catalogue G of universal milling machines, plain and vertical milling machines, Lincoln milling machines, grinders, screw machines, drills, slotters, etc.

The Payne Co., Inc., Elmira, N. Y. Bulletin No. 12 of Payne engines, for electric light and power service. These are either belted or direct-connected, and several views of this engine are given, also views of the parts.

The Burt Mfg. Co. Akron, O. Pamphlet entitled "The American Oil Filter," describing and illustrating the oil filter and purifier manufactured by this company. The Burt exhaust head is also mentioned.

Pawling & Harnischfeger, Milwaukee, Wis. Bulletin No. 12, which describes the standard I-beam trolleys built by this company. Chain block traveling cranes, and electric traveling cranes and hoists are also described and illustrated.

The Shelby Steel Tube Co., Pittsburg, Pa. Price list No. 12, Nov. 1902, of the Shelby cold-drawn seamless steel tubing for mechanical and engineering purposes. Hot rolled tubes are also manufactured by this firm.

The Arguto Oilless Bearing Co., Wayne Junction, Philadelphia, Pa. Catalogue of Arguto oilless bearings to be used in friction or loose pulleys, on shaft bearings, in friction clutch pulleys, on countershafts, etc. They are applicable to light or highspeed machinery where lubricants are undesirable, but not for heavy work. An abstract from the report of the Franklin Institute on Arguto oilless bearings is published in the back of the catalogue.

The Pratt & Whitney Co., Hartford, Conn. Standard size catalogue, Dec. 1902, describing the thread milling machine recently placed on the market by this company. This machine is built for the production of precision screws, worms, lead and feed screws, etc. The various parts are shown in detail, and four handsome half-tones illustrate the work, large and small, that it is capable of turning out. Various useful tables in connection with this work are given. The Pratt & Whitney automatic cutter grinder is also shown.

The Reeves Pulley Co., Columbus, Ind. General catalogue of the Reeves variable speed transmission. This catalogue, just issued, is standard size and profusely illustrated by half-tones and line drawings. The Variable Speed Transmission and its operation are described in detail, and two fine illustrations show clearly the workings of the different parts. Sizes from Nos. 0 to 12 are illustrated and a number of sketches show the application of variable speed to planers, shapers, lathes, milling and boring machines, drills, etc. Several testimonial letters are published and also price lists of the variable speed. The company also publish the "Paper Machinery" issue, which treats of variable speed transmission more at length.

MANUFACTURERS' NOTES.

The National Tool & Stamping Co., is the name of a new concern erecting a factory at Wayne Junction, Philadelphia, Pa. They will manufacture special tools and dies, and do general sheet metal stamping.

The Resck Machine Tool Co., Cleveland, O., are erecting a three-story brick factory building on Quincy and Craw Sts., for the manufacture of machine tools and steel balls, the latter formerly manufactured by the Cleveland Ball & Screw Co.

The Q. & C. Co., Chicago, Ill., recently made a shipment from their factory at Chicago Heights, of one of the largest special metal sawing machines to the United States government, to be used at the Cavite Navy Yard, Manila.

J. T. Slocomb & Co., Providence, R. I., have just put out a new morocco case, plush-lined, to hold their Nos. 1, 2 and 3-inch machinists' set, listed as No. 21. The special advantages of this case, which is illustrated in their advertisement in this number is that it can be readily laid in the tool box.

The name of the system of cost keeping devised by W. S. Rogers has been changed from "Universal Cost System" to "Industrial" Cost System. For information about this system Mr. Rogers should hereafter be addressed care The Bantam Mfg. Co., Bantam, Conn., instead of Keene, N. H.

The Joseph Dixon Crucible Co., Jersey City, N. J., published in their December number of "Graphite," an article on the experiments of Prof. W. F. M. Goss, of Purdue University, on the use of Dixon's graphite in air-brake equipment. These experiments are not only interesting but of value to all who have to do with locomotive engineering.

Mr. Daniel W. Pedrick is no longer connected with the Pedrick & Ayer Co. His entire time and attention are now given to the H. B. Underwood Co., of which firm he is the senior partner. He has been a partner of this firm since its organization, and is superintending the turning out of high-grade portable cylinder boring bars and other portable tools for railway repair shops for this firm.

George William Hoffman, 295 East Washington St., Indianapolis, Ind., manufacturer of the U. S. Metal Polish and "Barkeeper's Friend," informs us that the demand for his product has greatly increased this year. This paste is sold in powdered and fluid form and is used for polishing gold, silver and plated ware, nickel, tin, brass, copper, etc.

The Fox Machine Co., Grand Rapids, Mich., manufacturers of wood-working machinery, have just completed a four-story addition to their plant. They have purchased a larger engine, increased the boiler capacity and erected a new pattern storage building. They report that they have found these additions necessary owing to their rapidly increasing business.

The Crocker-Wheeler Co., Ampere, N. J., manufacturers of electrical machinery, report the shipment of eighteen orders for engine type generators of various sizes, to different parts of the United States. They state that their new mill building is now being occupied, enlarging their floor space by 60,000 square feet, and giving increased facilities for prompt deliveries on large orders.

W. S. Rogers, formerly of the Roller Bearing and Equipment Co., Keene, N. H., and of the Ball Bearing Co., Boston, Mass., has become the general manager of the Bantam Mfg. Co., Bantam, Conn. This company was organized two years ago for the manufacture of ball and roller bearings and under Mr. Roger's management will make the regular line of goods formerly manufactured by the companies at Keene and Boston.

MACHINERY.

February, 1903.

THE GREAT WEST-ALLIS PLANT

OF THE ALLIS-CHALMERS COMPANY, MILWAUKEE, WIS.

Edwin Reynolds.

THE views accompanying this article were recently taken at the new works of the Allis-Chalmers Co., Milwaukee, Wis., and we think all our readers will be glad of the opportunity to see how this immense plant looks now that it has so nearly reached a state of completion. The present Allis-Chalmers company operate the old E. P. Allis works, Milwaukee, as well as the new works; also the Fraser-Chalmers and the Gates Works, Chicago, the works of the Dickson Manufacturing Co., Scranton, Pa.; and they have absorbed the business of the Lake Erie Engineering Co., Buffalo, and transferred it to their other plants. The Chicago and Scranton plants build the mining machinery contracted for by the company, the latter taking some of the engine work also, leaving the Milwaukee plants free to carry on the bulk of the enormous engine business for which the company is best known to the public. The old E. P. Allis works are to be continued in operation, the same as before the new works were built, the latter serving simply to increase the resources of the company by doubling the capacity of the Milwaukee shops and to afford almost unlimited opportunity for future growth.

The new Milwaukee plant is situated at West Allis, a suburb of Milwaukee, which has the shipping advantages afforded by two railroads and is destined to become an important manufacturing village. Several other manufacturing plants have been located there and many houses are being built. The land controlled by the Allis-Chalmers company is about 100 acres in extent and if the business should become large enough to require all the buildings called for in the original plans, Milwaukee will have one of the largest groups of machine shop buildings in the world. Unlike nearly every other large establishment, however, they will not represent a haphazard growth, with buildings erected to meet present needs, without any particular regard to the future. The whole plan was carefully laid out by Mr. Reynolds, with whose name the accomplishments of the E. P. Allis company are inseparably connected. The floor areas of the machine shop, pattern shop, foundry, erecting shop, etc., as far as erected are carefully proportioned from data secured at the old works and additions to the plant may be made in such a way as always to maintain these ratios, if desired.

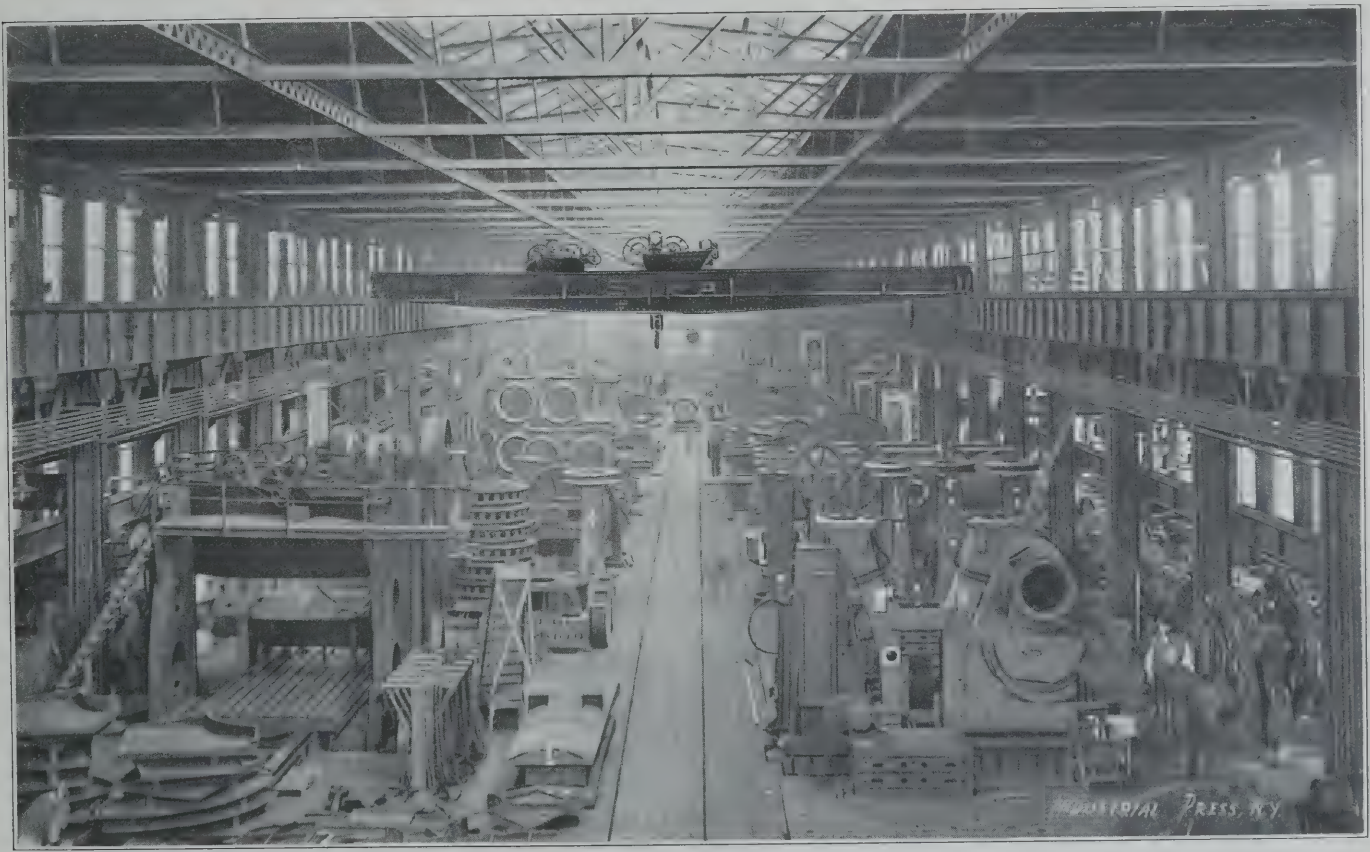


Fig. 1. One End of Machine Shop No. 1 of the West-Allis Plant of the Allis-Chalmers Co. A 10 x 12 Planer appears in the Foreground, and in the Right is a Floorplate 24 x 200 feet, on which Massive Portable Tools are used.

As shown in the ground plan, Fig. 3, the plant is constructed in units, entirely similar in principle (to use an illustration) to the unit system of filing cabinets and book cases now so generally employed in business offices. One complete unit has now been built and consists of a pattern shop and storage building, foundry, machine shops, power house, blacksmith shop, erecting shop, and yard storage, with cranes, tracks, etc. This unit consists of three buildings, the pattern shop, foundry, and erecting shop, which may be extended northward indefinitely, as indicated by the heavy dotted lines, and of three smaller buildings for machine shop and blacksmith shop purposes extending east and west.

These smaller buildings, and their proportionate parts of the larger buildings, really subdivide the main unit into three sections, and in making additions the shops may be extended to include one, two, three or more of these sections, as required; but in any case it will be possible to preserve the balance between the pattern and foundry work and the machine shop work.

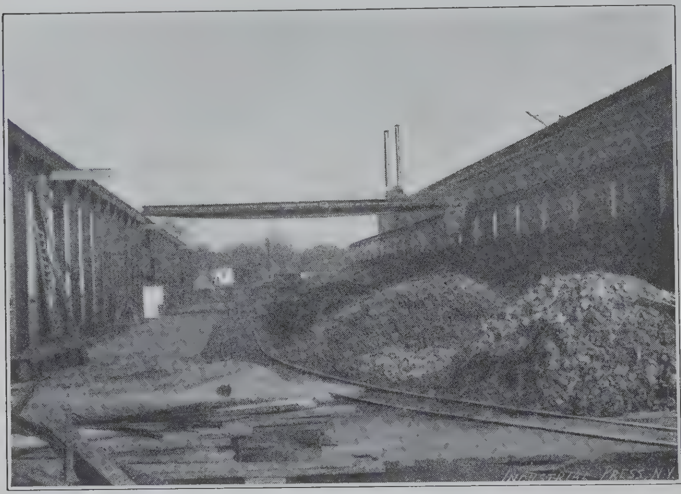


Fig. 2. Foundry Yard—Pattern Shop on the Left, Foundry on the Right.

Entering the works from the office indicated at the lower left-hand corner of the plan, the first building to be reached is the pattern shop and the pattern storage building, between which and the foundry is yard room for the storage of pig iron and coke and other supplies for the foundry. A view of this yard is shown in Fig. 2, and it will be noted that it is served by a traveling crane, supported by runways on columns. The material is brought to the yard on cars on a standard railroad track—part of an elaborate system of tracks extended through the different departments and to different sections of the yard on which the Company operate their own locomotives.

The pattern shop and storage building, as already stated, is one of the three buildings extending north and south, and which in the event of the enlargement of the works will be lengthened as much as required. The part of the building utilized for pattern storage is four stories high, with concrete floors supported by steel construction carefully protected by fireproof material. The part used as pattern shop is next to the foundry and is only one story high, giving excellent light over the whole floor area. Two views of this building appear in Fig. 5. That in the upper left-hand corner shows the pattern storage section and indicates the proportions of the structure, while that in the lower right-hand corner shows the pattern shop and part of the runway for the traveling crane mentioned above in connection with the foundry yard.

The next building to be reached is the foundry—another of the three structures running north and south. This is the building which appears at the center in Fig. 4. It is 220 feet wide, of the same length as the pattern building, and is divided into three bays, the center bay being higher than the two outside bays or wings, after the usual custom in such buildings, so as to admit side light through windows at the top. The foundry is equipped with three cupolas and approved apparatus is provided to facilitate charging with the proper mixtures of iron and coke. The traveling crane collects the material and brings it to the base of the inclined tracks shown in Fig. 6, where it is transferred by jib cranes to hydraulically-operated cars which convey it up the inclines to the charging floor above. The complete scheme embraces a pair of scales suspended from the hook of the traveling crane by which the pig or scrap iron

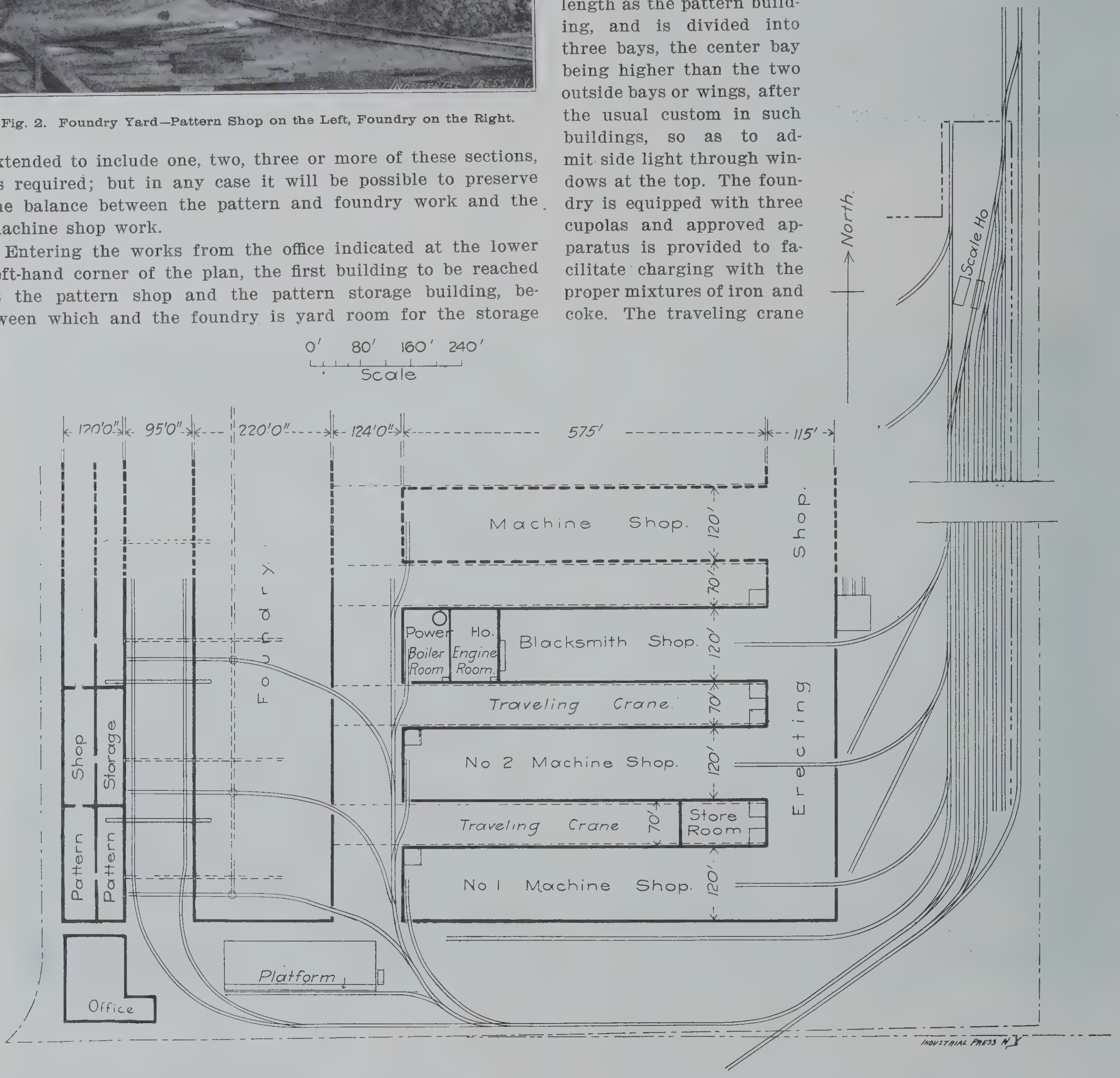


Fig. 3. Plan of the new Allis-Chalmers Plant.

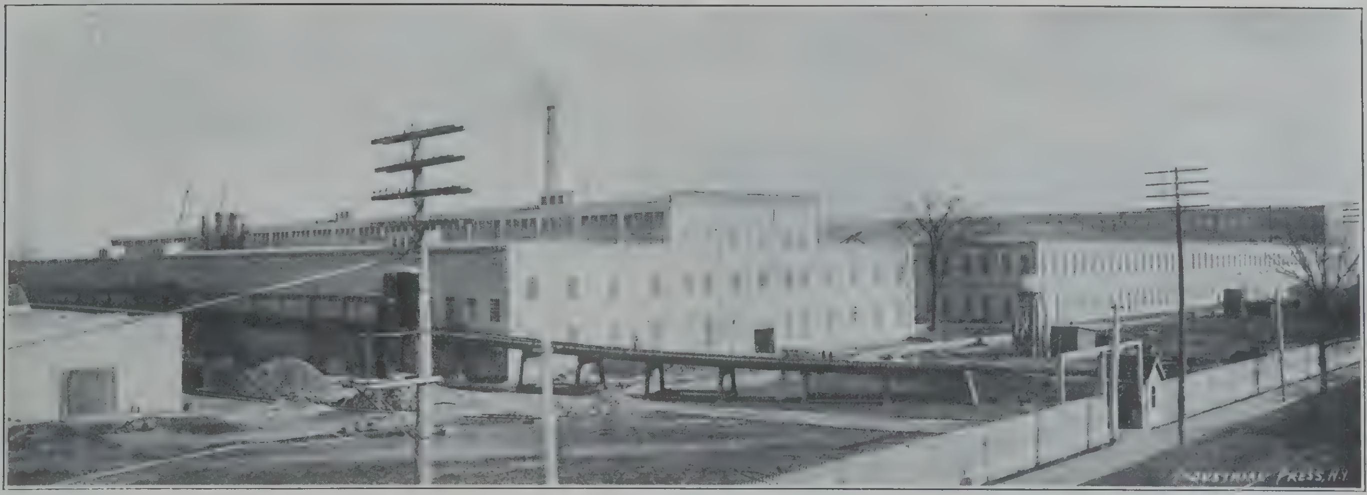
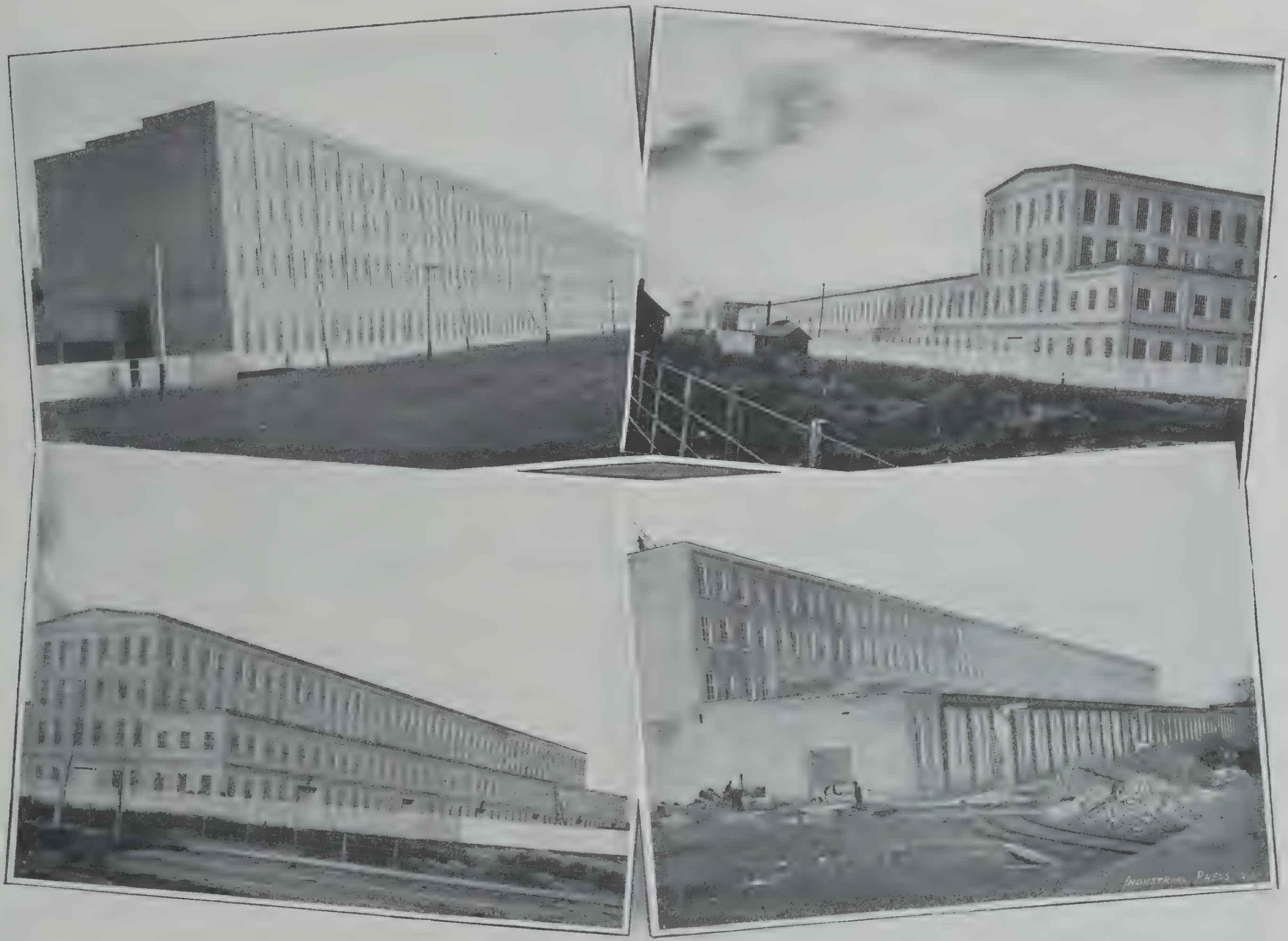


Fig. 4. General View of the New Works, looking Northeast. The Building in the Center is the Foundry. On the Right is Machine Shop No. 1, connecting with the Erecting Shop at its further end.

can be weighed before being deposited at the base of the inclines.

It has already been mentioned that the foundry yard is served by a railroad track, but to facilitate the disposal of sand and other material within the foundry itself there is also an elevated track, indicated clearly in the general view, Fig. 4, and which runs adjacent to the foundry one side of the building. Supplies of sand or other material are drawn up onto this track and discharged into bins provided for them, without further handling.



Pattern Storage Building.
Erecting Shop, looking Northwest.

End of Erecting Shop and No. 1 Machine Shop, looking Northwest.
Foundry Yard and Pattern Shop.

Fig. 5.

Next in order are the three buildings running east and west—two of which serve the purpose of machine shops and the third as a powerhouse and blacksmith shop. Beyond and communicating with these is the erecting shop shown in the lower left-hand view in Fig. 5. One end of it also appears in the upper right-hand view of this group, and in the distance is the No. 1 machine shop which adjoins it. Each of the machine shops and the blacksmith shop is 120 feet wide and 575 feet long. Shop No. 1 has a central crane span of 67 feet with two cranes of 80,000 pounds capacity. The sides are constructed on the gallery system and have auxiliary cranes of 20,000 pounds capacity. An interior view of this building is shown in Fig. 1. In shops Nos. 2 and 3 we believe the crane equipment is somewhat different, being adapted in each case to the class of work to be done. Most of the heaviest machine work is done in shop No. 1, which contains several unusually massive and striking machine tools. The main feature of the building is a floorplate 24 feet wide by 200 feet long, embedded in a substantial concrete foundation and equipped with several very massive tools of semi-portable character for machining the heavy frames and other engine parts that can be more conveniently and quickly handled by the floorplate system than by any other method.

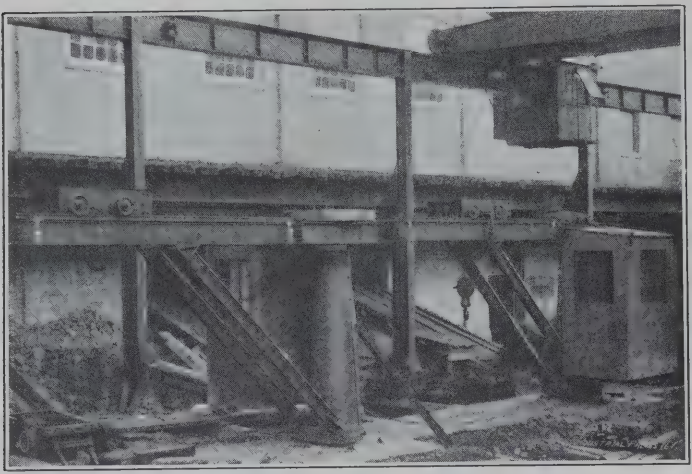


Fig. 6. Jib Cranes and Inclines used in Charging Foundry Cupolas.

The construction of this floorplate is the result of much study, and it is believed to be so substantial that it will stay in alignment a long time. There is ample provision, however, for adjustment, should it get out of level. The floorplate is built up of deep cast-iron sections 24 feet long by 8 feet wide, heavily ribbed and having T-slots for clamping tools or work. At intervals there are depressions in the upper top surface of the floorplate, for accommodating the projecting ends of foundation bolts and their nuts, and also the heads of the adjusting screws which, in each case, are placed beside the foundation bolts. These adjusting screws extend through the floorplate and bear against a small cast-iron plate embedded in the concrete, so that by slackening on the foundation bolt and turning the adjusting bolt the plate can be raised or lowered to bring it into adjustment; then, when the nut on the foundation bolt is again tightened the plate will be held solidly through the binding or clamping of the two bolts. After adjusting the sections of the plates in this way and leveling them, they are grouted in with cement.

The machine tool equipment of the floorplate is a remarkable collection of tools and indicates a disposition on the part of the management to provide every facility for turning out the heaviest class of work economically and accurately. Among other floorplate tools are two large Morton traveling shapers, 48x48x72 inches and one 72 inches by 72 inches by 11 feet, the latter being the largest shaper of this type ever built. The ram of this machine is of steel, cast hollow, 10x12 inches in cross section. The length of stroke is 72 inches, the saddle carrying the ram will feed vertically on its supporting column a distance of 6 feet, and this column in turn will feed on the bed of the machine 11 feet. The saddle is counterbalanced by an air cylinder on the rear of the column, furnished with pressure by a small compressor, motor-driven. The machine also has a milling attachment whose arbor is 6 inches in diameter, and may be used either for boring or milling, and which carries a 12-inch mill on its outer end. As in all Morton shapers this machine works with a draw cut.

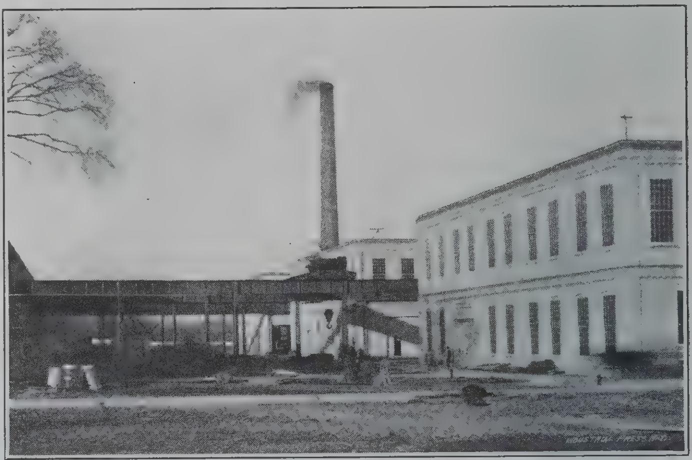
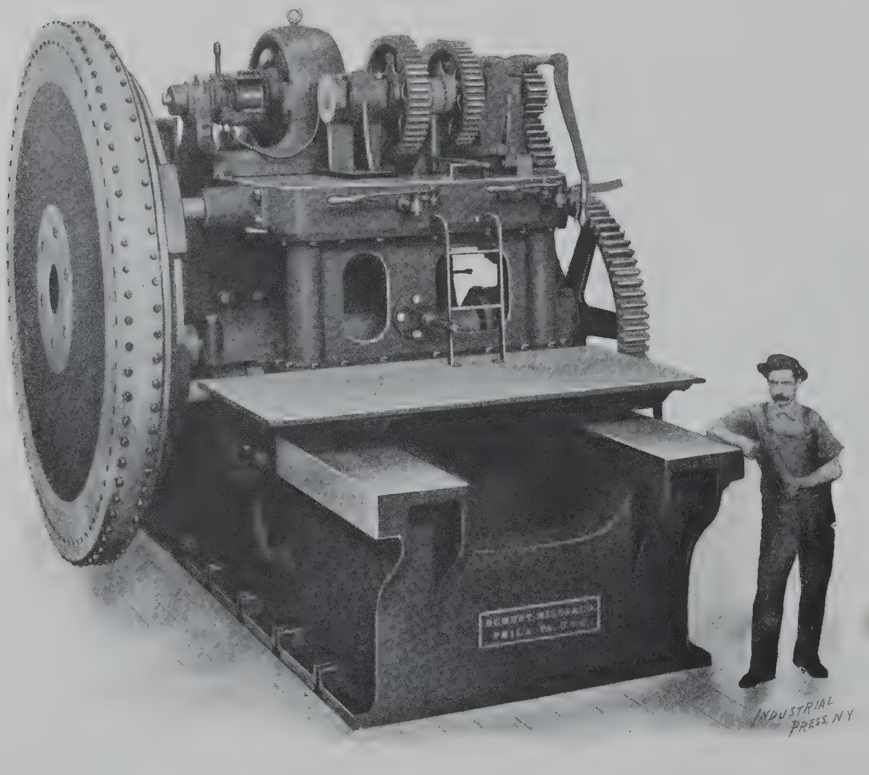


Fig. 7. Showing Runways for Traveling Cranes which Operate between the Machine Shops.

The most striking tools on the floorplate are a pair of 10-foot rotary planers built in the Bement-Miles shops in Philadelphia and which are the heaviest and largest tools of the kind we have seen. A view of one of them appears in Fig. 8. The cutter heads of the planers face each other and one of the machines will ordinarily remain in a fixed position while the other can be adjusted so as to take in work of greater or less length or width between the cutter heads. The movable machine is provided with rollers and is so designed that it can be raised off the foundation and supported by these rollers to facilitate moving along the floorplate, thus bringing it approximately to the correct position. The final adjustment is obtained by an endwise movement of the main spindle of either planer which can be adjusted out or in a distance of 7 inches. The following specifications of the machine were kindly furnished us by the builders. The saddle has a traverse of 16 feet on a bed 26 feet long. The faceplate is 10 feet 7 inches outside diameter and holds 75 cutting tools. There are three cutting speeds—of 22, 30 and 40 feet per minute, with feeds of 2, 4 and 8 inches per revolution, or an equivalent of 10 inches per minute at 40 feet cutting speed. A moment's thought on the part of the reader will show what this means in the way of rapid surfacing by comparison with the usual methods of removing stock. All of the gearing and clutches are mounted on a platform and are controlled by levers within reach of the operator, who need not change his position at all. For heavy surfacing, provision is made for backing up the periphery of the faceplate by means of adjustable slides that can be brought solidly against its inner surface.

Of the other interesting tools in this shop may be mentioned a 12x10 and a 10x10 planer, the former planing work 30 feet long, and two large boring mills, one 12x12 and the other 12x14, furnished by the Niles-Bement Pond Co. The largest planer appears in the foreground in Fig. 1. There is also a port boring machine of somewhat unusual



One of two 10-foot Rotary Planers in use on the Floor Plate of Machine Shop No. 1.

construction, built by the Grant Tool Co., Franklin, Pa. This was described in the June, 1902, number of MACHINERY.

The galleries of this building and of machine shop No. 2 are equipped with a great variety of smaller tools, furnished by different builders, which we will not undertake to enumerate; though it may be mentioned that a conspicuous installation is the large number of lathes furnished by the Lodge & Shipley Machine Tool Co. An interesting device in shop No. 2 is a dashpot-testing apparatus by which the valve gear mechanism of an engine can be run for any length of time and up to any speed. It is interesting to note also that the dashpots and similar engine parts are made on turret lathes, being turned out in quantities just as are the small parts of any machine which is manufactured by modern methods.

In the blacksmith shop there are, at present, four steam hammers, the largest being of 12,000 pounds capacity. Oil burners are used for the heating furnaces. On the outer end of this building, room has been left for the installation of the power plant, and at the time of the writer's visit one unit was running, and others were in process of erection. The engines are to be of the Reynolds-Corliss vertical type and there will be one unit of 100 K.W., one of 350 K.W., and one of 500 K.W. capacity. There is room here for two more 500 K.W. units, to meet future requirements. Both Westinghouse and Crocker-Wheeler generators are used and the Bullock multiple voltage system is employed for the distribution of the current in the works. The crane equipment throughout the plant is by Pawling & Harnischfeger, Milwaukee.

Continuing now to the erecting shop we find a building running north and south, 115 feet wide by nearly 560 feet long, arranged in two bays, one of which has 60 feet head room under the crane hook, served by a 75-ton crane. A 40-ton crane will be installed later. This section of the shop will be for assembling vertical engines, pumping engines, etc., which can be completely erected here before shipment. The other bay of the shop has 25 feet head room under the crane hook and will be used for the collecting of parts before they are needed for the erecting floor, and for shipping. The general design of the erecting shop and its relation to the machine shops which connect with it will be evident from the upper right-hand view in Fig. 5.

The first essential in an erecting shop is a substantial floor, and this has been secured by laying two feet of solid concrete on top of the clay soil which serves as foundation for all the buildings. Oak stringers were embedded in the concrete and leveled by the aid of a transit and grouted in. On these stringers a heavy plank flooring was laid.

The track and yard arrangements of the West Allis plant are complete in every respect. Connection is to be had with the Chicago, Milwaukee and St. Paul Ry. at the north, and with the Chicago and Northwestern Railway at the south.

Ranged on the easterly side of the yard are the tracks for the reception and shipment of freight, with spur tracks running into the erecting shop and to other sections of the yard. As represented in the drawing, Fig. 2, there is a break in the continuity of the tracks, this being done in making the sketch, because it was desired to show the arrangement of the upper or northerly switches, which in reality are beyond the limits indicated by the drawing. The switches are so placed that two tracks are open to the C. M. and St. P. Ry. for shipment or delivery, and two to the C. & N. W. Ry. for the same purpose. One of the tracks, in each case, is to be used solely for cars that are being loaded for shipment, and the other for cars containing freight to be delivered. This plan will reduce to a minimum the amount of switching to be done.

Beginning at the right, the first track is to be used for connecting the two railway systems. The next two are the shipping and receiving tracks for the C. M. & St. P.; the next two are for the C. & N. W.; and the next three are tracks through which connection may be had with the shops, foundry, and all the various departments of the works. To reach these tracks, however, by either railroad system, it is necessary that cars should pass over the single track at the north part of the yard, where the scales are situated, as indicated on the plan, thus ensuring that no supplies shall enter any part of the works without first being weighed and checked.

The yard crane equipment is no less complete than the railroad facilities. The crane arrangement between the pattern shop and foundry has already been described. There are traveling cranes similarly arranged between machine shops No. 1 and 2 and between the latter and the blacksmith shop, the runways for these extending across the yard space between the easterly ends of these shops and the foundry. In Fig. 7 the ends of these three buildings appear, and the crane tracks and one of the cranes are clearly visible. In the distance is the stack of the power plant.

It is a fortunate and pleasing circumstance in the life of Mr. Reynolds that he has lived to see the culmination of his efforts in the design and completion of this plant. He is over 70 years of age and his life has been marked by aggressive and original work in various branches of constructive engineering. Before going to Milwaukee he was prominently connected with the Geo. H. Corliss engine works, Providence, R. I., which, under the direction of their founder, became the leading works of their kind in the world. When Mr. Reynolds went to Milwaukee the E. P. Allis Co. were far from flourishing; but he has succeeded in doing with this concern in the West what Mr. Corliss did so long ago in the East; only on a more magnificent scale, and with the most elaborate plans for the future ever projected in the engine business.

* * *

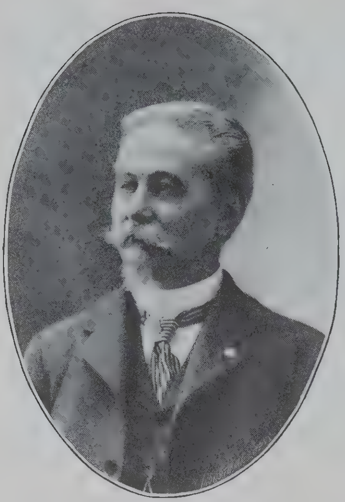
MUM'S THE WORD.

A curious tale of machine shop secrecy is told by a New England manufacturer of machines who recently made a trip to Australia and the neighboring islands, including New Zealand, where at Auckland he had the following experience: A local dealer in machinery asked the New England man if he wished to see a remarkable machine, one of which the like was not to be seen in all New Zealand. Of course an affirmative answer was given, whereupon the proprietor of a local jobbing machine shop was approached and asked for the privilege of seeing the machine in his shop. After much argument and a lengthy explanation of the visitor's business, the country from which he came, etc., the privilege was reluctantly granted. A portion of the main workroom had been partitioned off and the door leading into the little room thus made was always kept carefully locked. Even the belt holes were carefully screened so that none of the workmen in the main shop could peek through into the "holy of holies." The proprietor unlocked the door, fearfully ushered his guests within and quickly shut and locked the door behind them. There before them was a machine carefully covered with a tarpaulin which having, with due ceremony, been removed, revealed to the bewildered New England man, a Brown & Sharpe universal milling machine! His astonishment can be imagined; also his embarrassment. He did not know whether to laugh at the matter as a practical joke or to get angry, so made some non-committal remarks and withdrew as soon as he decently could. When once safely away from the shop he took his New Zealand friend to task and asked him why in the name of common sense he had been taken to see a machine with which he was, of course, perfectly familiar. The reply was that he, the New Zealander, wished to give the New Englander a practical demonstration of the difficulties which he met in selling new machinery. The proprietor of this shop had been enterprising enough to buy a milling machine and he did not propose that any of his rivals in business should get a glimpse of the machine or know anything about it. The proprietor had unboxed and set up the machine alone, and did all the jobbing work that came within its range. If the visitor had been from New Zealand or the neighboring island of Australia, he would have not been permitted to see it. So the dealer in machinery was unable to take prospective customers to this shop and there visually demonstrate to them the great advantages of the, to them, new machine.

SHOP CONSTRUCTION.—5.

FLOORS.

Oscar E. Perrigo.



In the construction of modern manufacturing buildings there are many methods of constructing a floor, varying all the way from the almost primitive "dirt floor" of the forge shop to the close-jointed smoothly-finished hardwood floor of the modern watch factory. Those which principally concern us in these articles, however, are such as are necessary in the modern machine shop, forge shop, iron foundry, etc., and these we may properly divide into six classes, viz:

First, those composed exclusively of earth, as the floor of the forge shop. Second, those composed of earth and concrete, like the floor of an iron foundry, as shown in vertical section in Fig. 1. Third, those of stone and concrete, as the main or ground floor of a machine shop designed for constructing and erecting heavy machinery, shown in Fig. 2. Fourth, those composed of stone or bricks, as required for engine and boiler rooms, etc., shown in plan in Figs. 3 and 4. Fifth, those of wood, supported by iron beams, as illustrated in vertical section in Figs. 5 and 6. Sixth, those composed entirely of wood, as shown in Fig. 7.

There are also certain conditions which will, in a great measure, determine the kind of floor to be adopted, as, for instance, the situation, the kind of work to be done and the weights which the floor will have to support. As to materials, there are those of each kind which it might be perfectly proper to use in other portions of the work of construction, but which would be objectionable in a floor. Stone should be of such nature and quality as to remain firm and hard, with no disposition to crumble away. Hence granite is the best, although there are other kinds which are nearly as good for certain purposes, and much cheaper. Generally, such as can be obtained near the work are used, to avoid the cost of transportation.

For paving, a hard, smooth-surfaced stone is needed. Sandstone wears away easily, and, therefore the harder varieties are preferable. Slate makes a very smooth-wearing and satisfactory floor. Granite is not usually employed for this purpose owing to the expense of obtaining it and the cost of cutting. Paving bricks should be hard-burned and of a quality to insure toughness, so that they may not be easily broken by accident. Many brick companies, in different parts of the country, now manufacture bricks for street paving which possess as good wearing qualities as most kinds of stone. Gravel should be free from soil, although a moderate quantity of sharp sand is not objectionable. When earth is used in making a floor a certain amount of clay should be added, to give an adhesive quality to the mass. Sand should be clean and sharp, free from soils and alluvial earth, and not too fine.

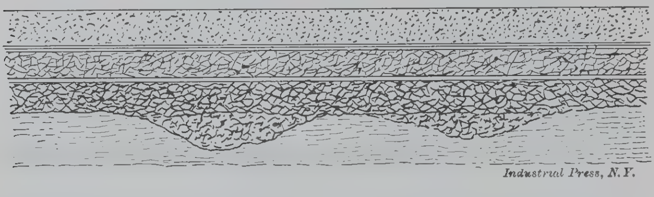

Industrial Press, N.Y.

Fig. 1. Earth and Concrete Floor.

Lumber should be so cut at the mill that the grain of the wood shall run as nearly as possible at right angles to the face of the board or plank, as shown in Fig. 9, rather than with the grain running in a direction nearly parallel with the face, as in Fig. 10. The reason for this is that the surface of the planks shown in Fig. 9 will wear smoothly even under very hard usage, while in the other case it will easily splinter up and present a very unsightly appearance, and will not last more than half as long as when properly cut from the log. Then, too, while the plank shown in Fig. 9 will warp very little, if any, that in Fig. 10 has a great tendency to warp, owing to the direction of the grain, and to the fact that the sap or outer portion of a log, being the newer growth, is less dense and consequently will contract more in the process of seasoning. Therefore the tendency is to distort the plank to the form shown by dotted lines in Fig. 10. Logs are usually cut up at the mill on the lines shown in Fig. 11. The boards taken off at the right and left, called "sidings," are trimmed on their edges separately and sold at a reduced rate, while the remaining center portion of the log is cut into stock boards, or planks of regular width and thickness.

To preserve the direction of the grain with relation to the faces of the boards or planks, the form of cutting shown in Fig. 12 would be advisable, but not as economical. This latter method is on the principle of quartering, as referred to in the furniture makers' term of "quartered oak," for instance. This form of cutting is shown in Fig. 13. It gives comparatively narrow boards, is expensive, and generally used for expensive woods, and for expensive work, as for fine furniture.

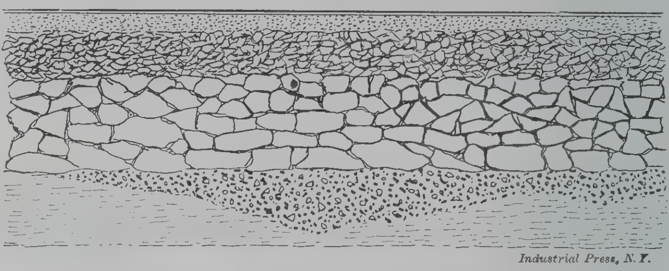

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Fig. 2. Stone and Concrete Floor.

The main, or ground floor of the machine shop being intended to sustain moderately heavy weights, both of machines and materials—as well as the hard usage in moving them from place to place, and the shocks of heavy work—is now usually made of concrete, and laid as shown in Fig. 2. In some cases those portions of floor included in the side wings are constructed of wood. This form is objectionable on account of the obstruction formed by the joining of the concrete floor and the planks; for at this point the former is apt to be cracked and broken, and the latter dented, split and defaced. This is particularly so if the planks are a trifle higher than the concrete, as is likely to be the case when newly laid down. Then, too, where such a floor is of wood it is necessary to excavate a foot or so below the floor timbers, to provide an air space for preventing the decay of the materials.

To lay a concrete floor for this purpose the earth should be excavated to the depth of from 18 to 24 inches, according to the weights which the floor is to carry. For ordinary purposes of machine shop work 22 inches is desirable and sufficient. If the ground is sufficiently firm at this level, no further preparation need be made. If soft and yielding, the excavation should be carried down to solid ground, and then filled up with solid earth, or still better with gravel, the excavation being flooded with water and the filling material thoroughly puddled as it is put in. On top of this bed should be placed a layer of coarsely broken stone, from 8 to 12 inches deep; and upon this a layer of crushed stones, none of which should exceed 2 inches in dimension. This layer should be from 4 to 6 inches thick. On this is spread a layer 2 to 4 inches thick of concrete composed of one part Portland cement, two parts clean, sharp sand, two parts clean gravel, and three parts fine crushed stone—all taken by measure, and not by weight. These ingredients should be mixed rather wet so as to settle well down into the spaces between the stones of the previous course. The concrete should be rammed hard and made perfectly level. Then comes a coating of from ½ to 1 inch thick, consisting of a mixture of one part Portland cement and two parts clean, sharp sand, which should be laid before the former course is dry, in order that the two courses may firmly unite. This last course is laid quite wet, to facilitate "floating"—that is, the levelling off and smoothing.

Sometimes the intermediate course of concrete work is made up of shingle (coarse gravel, stones, or pebbles), mixed with hot coal tar or Portland cement; but this has the objection that, whatever be the medium used for cementing the mass, it will not adhere to the rounded surfaces of the pebbles as effectively as it does to the more porous surfaces of crushed stone. Therefore, where subjected to hard usage, this shingle is more likely to disintegrate and break up, than where crushed stone is used.

The gallery floors of the machine shop are supported on built-up girders 20 inches deep, placed at each of the columns dividing the wings from the central part of the building. Carried upon angle bars riveted to the girders at a proper height, are the ends of 3x16-inch floor joists, placed 20 inches from center to center, their upper edges coming 2½ inches above the top of the girders, which space is occupied by a spiking piece. On these joists is laid a floor of 2½x6-inch planks, planed on both sides and matched with tongue and groove. This construction is shown in vertical section in Fig. 6. The girders here shown may, of course, be solid I-beams, with angle bars riveted on them for supporting the ends of the joists.

Where a lighter construction may be safely resorted to, on account of less weight to sustain, the form shown in Fig. 5 is proper. In this case an I-beam is used, say 10 to 15 inches deep, and the ends of the joists rest upon the lower flange of the beam. They should be of such depth as to project a couple of inches above the top of the beam, as shown, to provide a space for a spiking piece. In either case the ends of the joists should be beveled as shown, so that they may drop out clear in case of fire, without displacing or warping the I-beams.

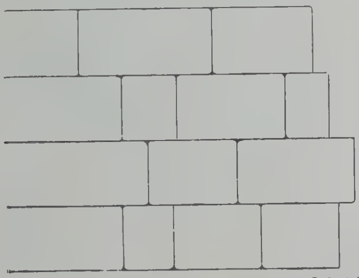


Fig. 3

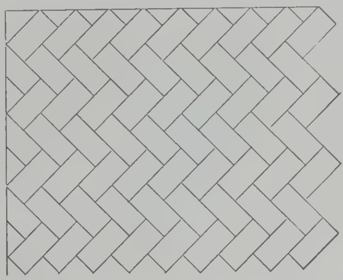


Fig. 4

Industrial Press, N.Y.

Stone or Brick Floors.

Wood joists may be dispensed with altogether, if safety from fire is of more consideration than first cost. In this case I-beams of proper strength are laid upon the girders, or with their ends resting upon the lower flanges thereof—say 4 to 8 feet from center to center—and upon them are laid planed and matched floor planks from 3x6 inches to 5x8 inches, according to the distance between supports and the load to be sustained. These are bolted to the upper flange of the I-beams. This arrangement is shown in Fig. 8. The vertical space occupied by these methods of construction varies considerably, as is shown in the engravings, and must be taken into account in designing the building.

Where it is desired to support floors by wooden beams, the form shown in Fig. 7 is proper. The dimensions of the beams must be sufficient to carry the load, taking into consideration also the distance between supports. The ends of the beams resting in the brick wall should be upon a "header course" of bricks, as shown, and the ends of the beam bevelled off the same as if used in connection with an iron girder or I-beam, so that in case of fire the beam will fall freely out of the wall without injuring it. Floor joists are laid upon the beams in the usual manner and spiked to them. Wooden floor joists should be braced by a "bridging" of, say 2x3-inch scantling, as shown, placed at intervals of from 4 to 8 feet, according to the dimensions of the joists and the weights they have to support.

In using floor planks of 3 inches or over in thickness it will be found more economical to groove both edges of the planks and insert a separate piece as a tongue, than to cut a groove in one edge and a tongue on the other.

The selection of proper lumber for floors has already been referred to. It is often profitable to consider those things that have failed since it has been well said that "we learn as much by one failure as by two successes." And the failures in shop floors are prolific sources of much annoyance and expense. A certain machine shop floor was laid upon round chestnut timbers, flattened on top and bedded in gravel laid over "made land," that is, loosely filled in with refuse matter of any sort easy to obtain. The floor proper was of 2-inch spruce planks. The result was that within a year the chestnut timbers and the under side of the planks began to decay, and since that time about one-half of the timbers, and nearly all the floor planks have been replaced each year, the patching-up process going on at intervals, and the result being an unsightly as well as expensive and annoying affair. Within a hundred feet of this floor was another of 2-inch planks laid on 3x12-inch joists, supported on 12x12-inch timbers resting on piers, raising the floor about two feet above the ground. Twelve years after this was laid some planks were removed to put in a machine foundation, and the joists and timbers were found looking nearly as fresh and new as when they came from the lumber yard. Their elevation above the ground and the ventilation of this space by small gratings in the side walls were evidently the cause of their preservation. These cast-iron gratings, say 10x18 inches, should be inserted at least every fifty feet in the walls of buildings whose ground floors are of wood, and at least a foot of ventilating space should be left between the ground and the floor.

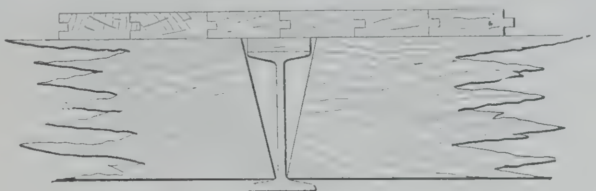


Fig. 5

Floor Supported by I-beam.

Another example, equally instructive, was a second floor of a machine shop. It was of 2½x6-inch spruce planks, properly supported. They were grooved on each edge ¾-inch wide and strips were inserted as shown in Fig. 14. The builders evidently thought that planks 2½x6 inches, with inserted tongues, would make a good and substantial floor. And so they would have, but the unfortunate selection of the planks included many with the grain running in the wrong direction, which caused much warping and distortion. Fig. 15 is from a sketch taken at the head of a stairway, careful attention having been given to the direction of the grain and the distorted form of the planks. It is, perhaps, needless to say that the tongues were split, and in some cases the planks also.

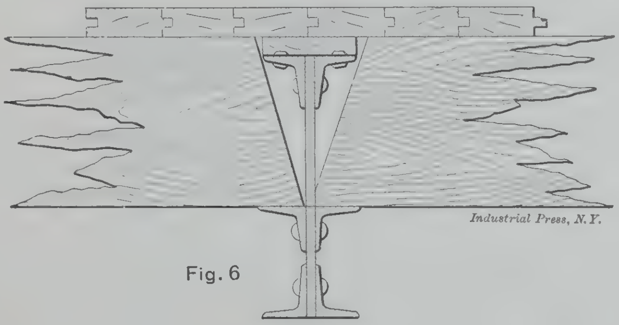

Industrial Press, N.Y.

Fig. 6

Floor Supported by Built-up Steel Beam.

Formerly the timbers most used in ordinary construction were of spruce. While this wood is well adapted for floor planks, it has very serious objections when used as supporting timbers. There is great liability to warp, twist and crack as the seasoning process goes on, while its strength is not as great as some other easily obtained woods. For instance, hard pine is superior in this respect, while it is about 35 per cent. stronger than spruce, and its usual cost is only about 20 per cent. greater.

The foundry floor is subjected to a very considerable weight, both in molding sand and in the castings produced, but the rough usage and shocks which the machine shop floor is called upon to withstand, are not met with here. Consequently there is no need of such an expensive preparation. The ground is prepared in the same manner as for the machine shop floor, except that it is only 12 inches below the floor line. This space is first covered with a 4-inch layer of crushed stone, over which is poured a thin mixture of one part Portland cement and two parts sand, mixed rather wet. Then a concrete is made of the same mixture and finely crushed stone, and laid to a depth of about 3 inches. On top of this is spread a flowing coat of the cement and sand mixture from ½ to ¾-inch thick, which is properly levelled off. All this having thoroughly set, the remaining portion of about 4 inches is made up of molding sand.

Pits are dug in the central portion of the foundry floor, of such number, area and depth as the contemplated work renders necessary. The bottom is covered with 6 inches of concrete and laid with two courses of hard bricks. The side walls of the pits are 8 inches thick and are built of hard bricks, all laid in cement mortar. The top of the wall is level with the final cement coat of the floor. If castings of ten tons or over in weight, and with comparatively small bases are to be made in one of these pits it will be necessary to put down a more substantial bottom. Excavation should be made to solid ground, or "hard pan," and large stones laid in cement mortar built to within about a foot of what is to be the bottom of the pit. Then proceed as above for making ready for the side walls. Care should be exercised in ramming or puddling, or both, to fill in around the side walls.

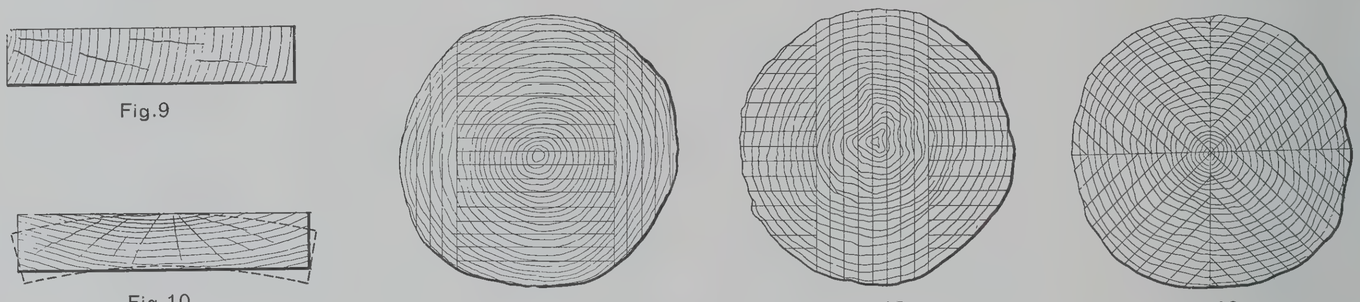


Fig.9

Fig.10

Fig.11

Fig.12

Fig.13

Industrial Press, N Y.

Methods of Sawing up Timber.

The floor of the forge shop is a still more simple matter than that of the foundry. The ground is prepared as before, and levelled off a foot below where the top of the floor is to be. This space is filled in with clean gravel mixed with clay, in the proportion of three parts of the former to one of the latter, laid down wet and thoroughly rammed down with a broad-faced rammer. Sharp sand, or the fine cinders from forges are sifted over this to prevent the surface from becoming muddy when accidentally wet. In the case of a forge shop, concrete is hardly advisable, being liable to be broken up by the heavy shocks from hammers and the rough usage to which it would be subjected. Of course it might be made thick enough to endure these conditions, but would be quite expensive and would answer the purpose no better than a hard-rammed floor of earth, as above described.

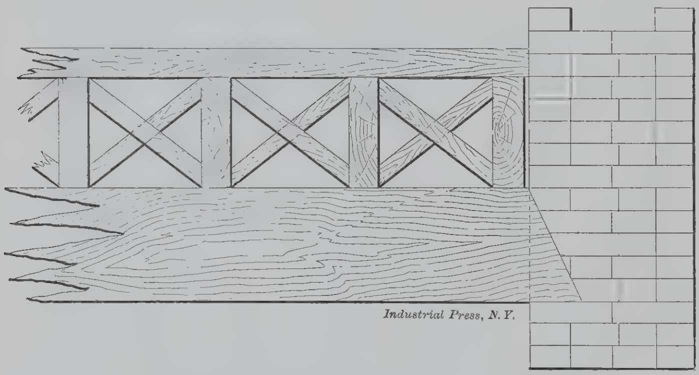

Industrial Press, N. Y.

Fig. 7. Floor with Wooden Beams.

For the floor of the boiler room, flag-stones, or hard-burned bricks may be used, whichever is found most convenient. If stones are used they should be cut to a certain width, in one direction at least, in order that they may be laid in courses so as to "break joints," as shown in Fig. 3. They should be from 1½ to 2½ inches thick. Supposing the ground to be sufficiently solid for the purpose, it is prepared by levelling, the same as heretofore described and at least 4 inches plus the thickness of the stones below where the top of the floor is to be. Sharp sand should be filled in 4 inches deep, and the stones laid upon this, the sand being rammed closely under each course as laid. When completed, dry sand to the depth of ½ inch is spread over the whole and swept back and forth to force as much as possible down through the joints. This is the cheaper and more simple method. If it is desired to make a more substantial pavement, the earth should be levelled off at such a height that only an inch space is left between it and the stones, and an inch course of a mixture of one part Portland cement and two parts of sharp sand worked up rather soft. The stones are laid on this while it is wet, and all spaces filled as each course is laid and levelled. Some masons may prefer to make this mixture with a portion of lime added, the same as in cement mortar.

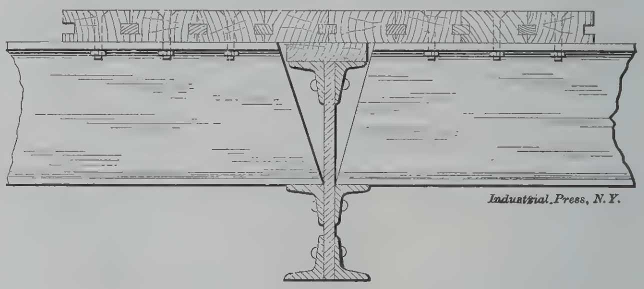

Industrial Press, N. Y.

Fig. 8. Floor Supported Entirely by Steel Beams.

Should bricks be used they may be laid on either the sand or cement bed the same as described for stone, except that about half the depth of sand will be sufficient. They should be arranged in the form shown in Fig. 4, by which method they are firmly bound together, and, if laid only upon sand, will retain their places for a long time. They are in some respects to be preferred to stone. Where the ground is soft or has soft spots, it will be necessary to excavate to comparatively hard ground and then fill in with solid earth—preferably gravel—which is to be tightly rammed or puddled to make it firm. Upon this the layer of sand may be placed as described.

It is sometimes desirable to have engine room floors paved also, and occasionally with much larger and heavier stones than those described above. They should be carefully laid in cement mortar on a good concrete bed. If rolled-iron plates, or cast-iron plates are to be used they should be supported by brick piers and iron bars, or by brick walls supporting their ends, and at other points if their dimensions render it necessary. Cast-iron plates may be made with strengthening ribs on their under side, by which means the supports may be much further apart.

The modern engine room is a much better appointed department than formerly. It should have a floor of narrow, matched hard pine, smoothly levelled off by hand planing, and the surface kept oiled with boiled linseed oil. The floor of the storehouse is of 2-inch planks laid on 3x12-inch joists, placed 15 inches from center to center, which in turn are supported by timbers 10x12 inches, placed 10 feet apart, from center to center and resting on piers, leaving 15 feet between supports. If the load which this floor is to carry warrants it, this distance should be reduced to 10 feet. The floor planks may be matched if desired, but for a floor for heavy machinery storage they need not be either matched or planed. The carpenter shop floor is of similar construction to the above except that the joists are 2x10 inches, laid 18 inches from center to center, and supported at distances of 13 feet by 8x10-inch timbers, resting on piers 10 feet apart.

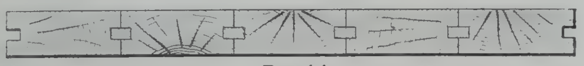


Fig. 14

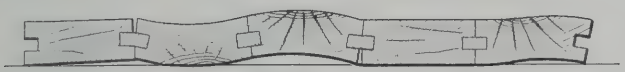


Fig. 15

Industrial Press, N.Y.

A Floor that Warped out of Shape.

The cupola platform of the foundry is of 2½-inch planks laid on 3x12-inch joists, placed 12 inches from center to center, and supported in their centers by a 10x12-inch beam, whose ends rest in the brick walls, and its center upon an 8x8-inch post. The floor, at least in the vicinity of the cupola, should be protected by sheet iron smoothly nailed down. If preferred, the floor may be constructed entirely of iron. In this case, plate girders or I-beams should carry cross supports and the floor be composed of cast-iron plates reaching from one support to the other, and having supporting ribs cast on their under sides. This form would, of course, make a much better method of construction, and in such a situation, much safer from the danger of fire, although more expensive.

The floors of the washrooms in the power house are of 1½x6-inch matched planks, planed on both sides, and laid on 2x12-inch joists placed 16 inches from center to center.

Floors in the office building, including the drawing room and pattern shop, are laid with a lining of ordinary pine ⅞-inch thick, and covered by 1⅛-inch hard pine, planed and matched, and not over 3½ inches wide, with the grain of the wood as shown in Fig. 9 The floors are laid on 3 x 12-inch joists placed 16 inches from center to center and supported by 10x12-inch beams set 12 feet from center to center. For the second floor these beams are supported on iron columns in the office and on 8x8-inch posts in the tool room, set 16 feet apart, making four posts or columns in the building 50 feet square, outside measurement. The timbers of the ground floor are supported on brick rising from the ground, which is excavated to a depth of at least three feet below the floor. One of these piers is under each post or column. In place of wooden beams and joists, iron or steel girders or I-beams may be introduced, making a construction more nearly fireproof, particularly for the second floor, but adding materially to the expense.

The floor of the pattern storage loft is of 1½-inch matched planks laid on 3 x 12-inch joists placed 16 inches from center to center and supported by I-beams 15 inches deep, one end resting in the front wall and the other on an 18-inch box girder carrying the rear wall and resting on iron columns, as shown in the plan.

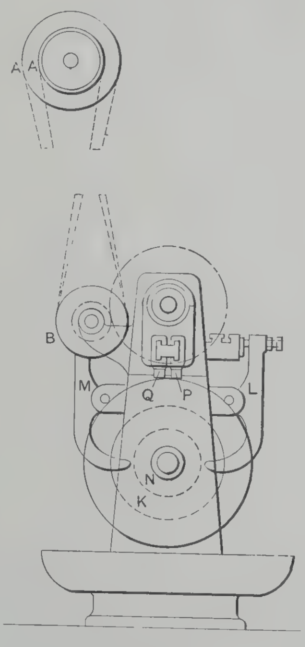
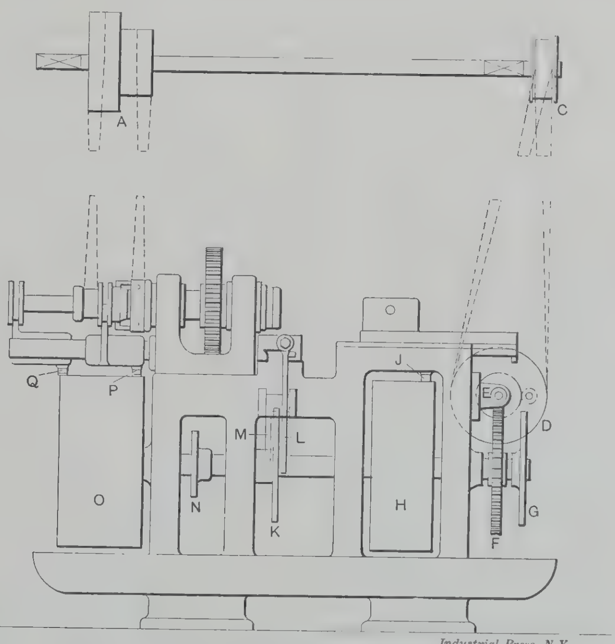


Fig. 2.



Industrial Press, N.Y.

Fig. 1. End and Side Elevation of Screw Machine.

As to the kind of lumber used in the floors of manufacturing buildings, spruce is by far the most common, and if properly selected is best for all ordinary purposes. Hard pine makes an excellent floor and is preferable where extra expense is not an obstacle. Occasionally when cost is a secondary consideration, and a perfectly smooth surface is necessary, floors of hard maple are laid and carefully surfaced off by hand-planing. This makes probably the most durable of any of the wood floors.

The writer saw a floor about 125 x 250 feet, prepared with a concrete bed and then laid on the wet flowing coat with hard maple blocks 2-inch x 4-inch x 12-inch laid on edge and in the "herring-bone pattern" shown for bricks in Fig. 4. After the concrete had thoroughly set the surface was hand-planed and oiled. Of whatever kind of wood floors are made the material should be well seasoned, and if shrinkage cracks are to be avoided, the narrower the planks are the better, although three inches may be the minimum width. If they are three inches thick or more, then six inches should be the minimum width.

* * *

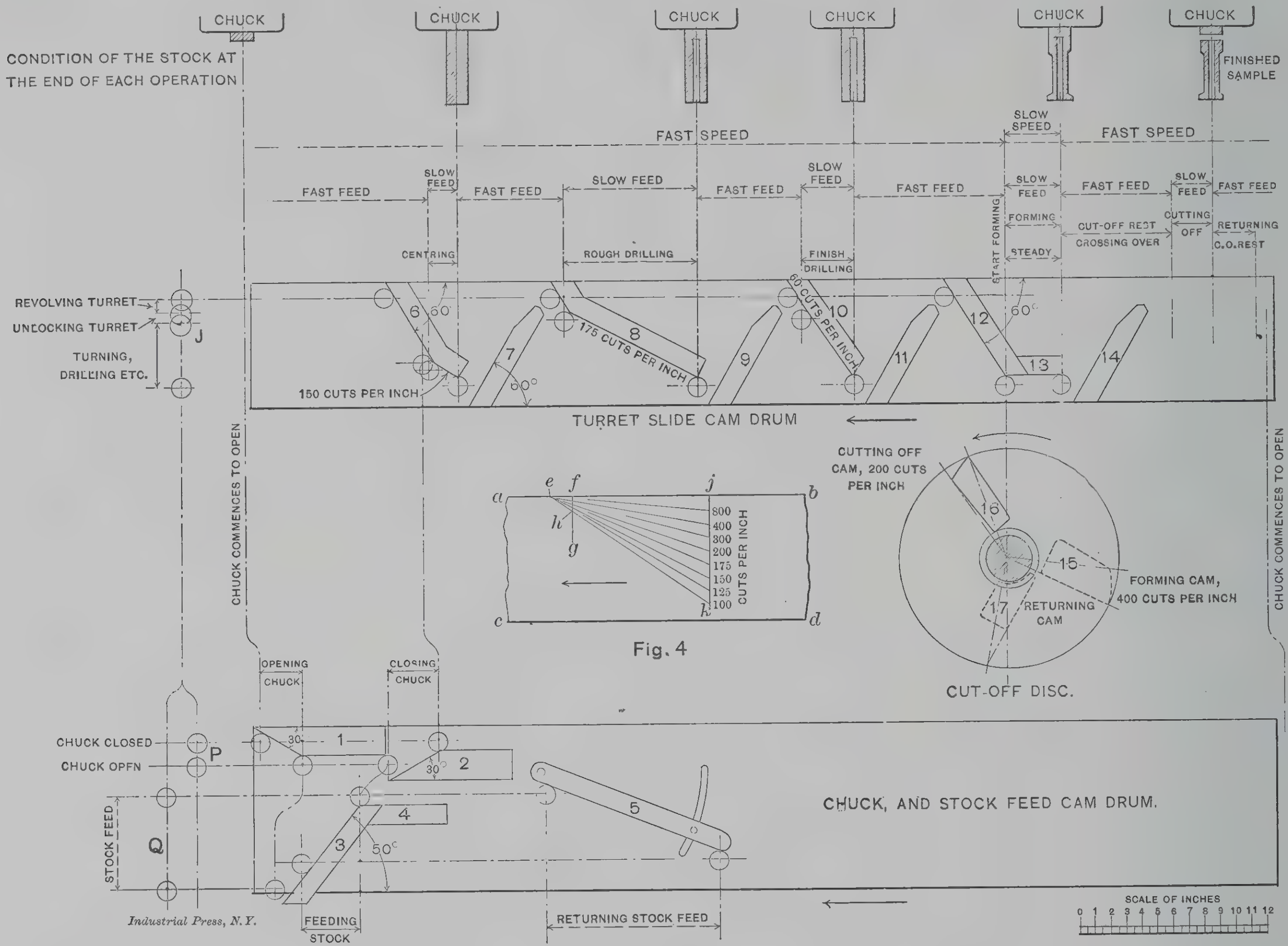
CAMMING AUTOMATIC SCREW MACHINES.

EXPLANATION OF PRINCIPLE, AND DEMONSTRATION.

Very little has ever been published on the subject of camming automatic screw machines of the Spencer or Hartford type for the reason, we believe, that the problem has been usually attacked by the "cut-and-try-method" in which "judgment" and the personal experience of the tool-maker doing the camming were the principal factors, calculations being ignored as much as possible. We do not mean by this that the universal practice is to follow this method for, happily, it is not; but the methods pursued by those who handle the problem intelligently have not, with possibly a few exceptions, been given to the public. For this reason we think the following reprint of an article on the subject by W. A. Jeboult published a few weeks ago in the *Mechanical World* (Manchester), will be found to be of unusual interest. We hope to get something on the same subject from our contributors who may be able to give information of further interest.

Fig. 1 is a side view, and Fig 2 an end view of the machine to which the cams are to be fitted. *A A* are the main driving pulleys on the countershaft. The drum shaft is driven from the countershaft by the feed pulley *C*, thus driving either of a pair of pulleys *D*, which contain a differential gear, and so can drive the worm *E* one revolution for one revolution of the differential gear pulley (the fast feed), or one revolution of worm *E* for 60 revolutions of the differential gear pulley (the slow feed), the ratio of the differential gear in this case being 60 to 1. The fast feed is used when bringing the tools, etc., up to the work, unlocking and revolving the turret, also when opening and closing the chuck, feeding the stock, etc.; the slow feed is used when the tools are actually cutting. The worm *E* drives the worm wheel *F*, and thus revolves the drum shaft to which the drums and disks are keyed. To the change feed disk *G* are clamped adjustable dogs, which engage with a pin on the end of a belt-striking lever (not shown), and so shift the belt from the fast feed differential gear pulley to the slow feed differential gear pulley and *vice versa.* The turret slide cam drum *H* has cams fixed to it, and moves the turret backward or forward by the cams pressing against the bowl (roller) *J*. As the turret is brought backward, a fixed cam on the turret slide withdraws the locking pin, and as soon as this is effected a lever engages with an indexing ring fixed to the under side of the turret, and so revolves it, thus bringing the next tool into line, the locking pin then being forced in by a spring. The cut-off disk *K*, to which are fixed the forming and cutting-off cams, etc., works the cut-off rest through the double-ended levers *L* and *M*, which are placed one on either side of the disk. The change speed disk *N* has adjustable dogs clamped to it, which alter the position of the driving belts on the head to fast or slow speed, or forward and reverse, etc., as required. The chuck and stock feed cam drum *O* has cams fixed to it, which open and close the drawback collet chuck by means of the bowl *P*, etc.; this drum also takes the cams which work the stock feed by the bowl *Q*. The following are the particulars required for the case under consideration:

Main driving pulleys *A*	Diameter 12 and 8 inches
Feed pulley *C*	Diameter 7½ inches
Back shaft pulleys *B*	Diameter 9 inches
Ratio of gear in head	3 to 1.
Differential gear pulleys	Diameter 12 inches
Ratio of differential gears, fast feed	1 to 1.
Ratio of differential gear, slow feed	60 to 1.
Worm *E*	Single thread
Worm wheel *F*	No. of teeth, 104
Cam drums *H* and *O*	Diameter 21 inches
Cut-off disk *K*	Diameter 14 inches
Bowls *J*, *P* and *Q*	Diameter 1¼ inches



Industrial Press, N.Y.

Figs. 3 and 4. Diagram showing Method followed in Laying Out the Cams of Automatic Screw Machines.

We also measure the distance from the edge of the turret-slide cam drum (see Fig. 3, left-hand side) to the farthest "out" and "in" positions of the bowl *J*, and see at what distance from the edge of the drum the unlocking and revolving of the turret take place. On the chuck and stock feed cam drum we measure the distance from the edge of the drum to the position of the bowl *P* when the chuck is closed, and again when the chuck is open; also the position of the bowl *Q* when the stock feed collet is as far forward as it will go. This position had better be taken when the chuck is open. The distance from the edge of the drum to the position of the bowl *Q*, to give the longest feed of stock that the machine is capable of taking, is also measured. Now, referring to Figs. 1 and 2, the bowl *J* is on the vertical center line, but it will be seen that the bowls *P* and *Q* are not on the vertical center line, but at equal distances on each side of it; this distance should be measured. These positions of bowls can be drawn down to any convenient scale, as shown to the left of Fig. 3. We also draw two rectangles to represent the two cam drums, developed as shown. The chuck and stock feed cams may also be drawn in. To start with, we assume that the chuck is closed, and that the bowl *P* runs up the cam 1 until the "open" position is reached. We now lay out the position of the stock feed bowl *Q* to feed the longest amount of stock the machine will feed, and at the same distance between *P* that there is between *P* and *Q* in Fig. 2. We next draw in the stock feed cam 3 just clear of the bowl, to be sure that the chuck is quite open before the stock commences to move. The bowl *Q* runs up the stock feed cam 3 (which is set at 50 deg.) until the farthest "in" position is reached; then the corresponding position of *P* can be laid out, and the chuck-closing cam 2 drawn in just clear of the bowl *P*, which runs up cam 2 and closes the chuck. The retaining cam 4 is to prevent the closing of the chuck from forcing out the stock feed. The stock feed returning cam 5 is adjustable, the amount of stock fed forward being regulated by the position in which cam 5 leaves the bowl *Q*. This cam can be put in any convenient position on the drum, but it is advisable to keep all the cams on this drum within half the circumference, so that should a job have to be done on the machine necessitating the chuck and stock feed to be operated twice in one revolution of the cam drum, the extra set of cams could be put on without displacing any already fixed. It should be noticed that in the example the stock feed cam 3 will feed forward the greatest length of stock that the machine will take, although not required in the present case. These cams can therefore be considered as standard for the machine.

The turret slide cams are not quite so simple, and a few calculations must be made previous to starting; also the list of operations and travel of tools settled. The sample under consideration is first to be centered at 150 cuts per inch; then to be rough-drilled at 175 cuts per inch; then finish-drilled at 60 cuts per inch—all these operations being done on the fast speed of the spindle. Then a steady is to run up, and the forming to be done at 400 cuts per inch on the slow speed of spindle, the steady to return, and cutting off to take place at 200 cuts per inch on the fast speed of spindle, thus using all four holes in the turret and maximum travels.

Now construct the diagram of cutting angles of turret slide cams, Fig. 4. It should be noticed that all the machining operations performed by the turret are done when the machine is running at the fast speed and slow feed, so that the diagram is to be constructed for the fast speed and slow feed only. The first thing to know is the number of revolutions made by the spindle when running at the fast speed, for one revolution of the cam drum. This can be obtained from the list of particulars, thus:

Worm wheel *F*, 104 teeth.
Worm *E*, single thread.
Differential gear shaft = 104 revolutions.
Ratio of differential gear, slow feed, 60 to 1.
Differential gear pulley $D = 104 \times 60 = 6240$ revolutions.
Differential gear pulley $D = 12$ inches diameter.
Feed pulley $C = 7\frac{1}{2}$ inches diameter.

$$\text{Countershaft} = \frac{6240 \times 12}{7.5} = 10{,}000 \text{ revolutions.}$$

Main driving pulley *A*, fast speed, 12 inches diameter.
Back shaft pulleys *B*, 9 inches diameter.

$$\text{Back shaft} = \frac{10{,}000 \times 12}{9} = 13{,}333 \text{ revolutions.}$$

Ratio of gear in head, 3 to 1.

$$\text{Revolutions of spindle for one revolution of drum, } \frac{13{,}333}{3} = 4444$$

The diameter of the cam drum is 21 inches, and the circumference is 65.973 inches, so that the number of revolutions made by the spindle for 1 inch circumferential travel of the drum $= \frac{4444}{65.9} = 67.4$. Then the circumferential length of drum to equal 100 revolutions of spindle $= \frac{1 \times 100}{67.4} = 1.48$ inches. Assume *a b c d*, Fig. 4, to be a portion of the turret slide cam drum laid out flat. From *e*, at the distance 1.48 inches, drop the perpendicular *f g*, and *h*, 1 inch down on *f g* measured from the line *a b*, draw a line joining *e*. Now it will be obvious that if a cam is fixed on the drum to coincide with the line *e h*, while the drum moves from *e* to *f* the turret will move from *f* to *h*; and as the distance *e f* is equal to 100 revolutions of the spindle, and *f h* is equal to 1 inch, then the angle *e f h* is the angle for a cam to give 100 cuts per inch. For convenience it is necessary to construct the diagram larger than *e f h*, so we multiply *e f* and *f h* by any suitable number (in the example it is 7, this giving a diagram large enough to work from). To obtain any other number of cuts per inch, it will be noted that 200 is half the length of the line *j k* for 100 cuts per inch; 400 is half the length of the line for 200, and so on.

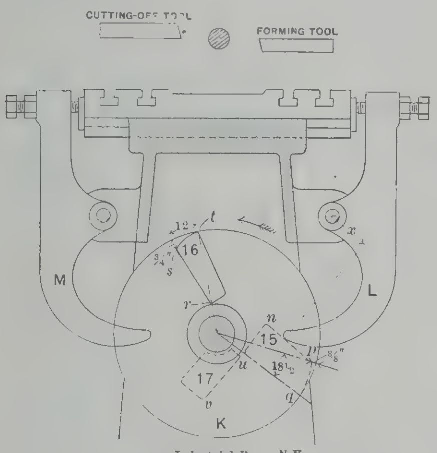


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Fig. 5.

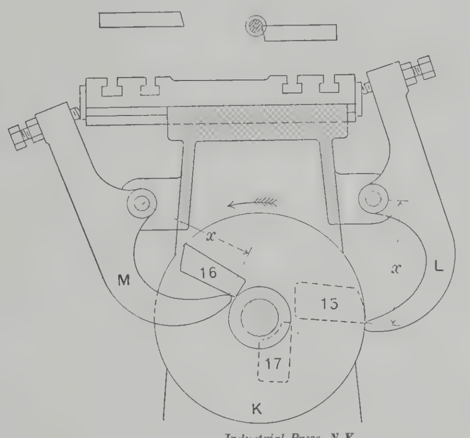

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Fig. 6.

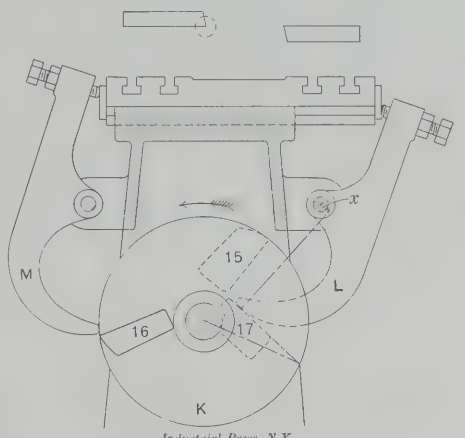

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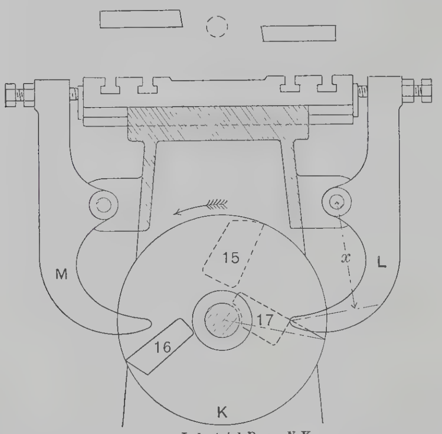
Fig. 7.

The turret slide cams can now be proceeded with. Referring to Fig. 3, while the chuck was closing, the cam 6 had carried the bowl *J* nearly up to its work, allowing a little clearance, to be sure the chuck was closed before the centering tool began to cut. The amount of travel on the slow feed for centering having been decided on, the angle of the cam for 150 cuts per inch can be obtained from the diagram, and drawn in. The bowl *J* can then be shown at the end of its travel. It is understood that no cams are to be placed on the drums that would force the bowls further than their extreme positions shown at the left of Fig. 3. The returning cam 7 can next be drawn in, allowing room for the bowl to pass between the cams 6 and 7; the end of cam 7 is taken off to revolve the turret a trifle slower, and bring the turret to rest with less shock; the rough and finish drilling cams can be treated in a similar manner to the centering cam 6.

The steady cam 12 can be drawn in, and at the position where the bowl *J* has carried the steady up to its work, a line can be erected showing where the forming is to start. The forming and cutting off being done by cams on the cut-off disk, these must be considered separately, and then referred back to the turret slide cam drum. The cut-off and forming tools are to be kept far enough apart when in the mid-position to let the box tools pass between; this is very important on some jobs.

Fig. 5 shows the cut-off rest in mid-position and the forming lever *L* about to run the cut-off rest up to the job; the cut-off and forming levers are the same length on each side of the fulcrum. For the job in hand it is necessary to form ¼-inch deep; to this we add an extra ⅛-inch for contingencies, making ⅜-inch deep at 400 cuts per inch on the slow speed of the spindle. The number of revolutions made by the spindle when on the slow speed for one revolution of the drum is 2,963, which number is obtained by the same method as used for the fast speed. The revolutions of spindle required to form ⅜-inch deep at 400 cuts per inch is $\frac{400 \times 3}{8} = 150$. While the drum makes one revolution or moves through 360 deg., the spindle on the slow speed makes 2,963 revolutions; then the number of degrees moved through by the drum while the spindle makes 150 revolutions on the slow speed $= \frac{360° \times 150}{2963} = 18.2°$, say 18½°. The portion of the cam 15 is laid out as shown in Fig. 5. The radius for *p q*, which is the part of the cam used when the forming tool is cutting, is approximately correct if taken as half the diameter of the disk; but in the case of a cam containing a large number of degrees, a correct spiral form should be used to give a uniform cut.

Fig. 6 shows the forming lever *L* after forming is finished and the cut-off lever *M* is about to move the cut-off slide across and bring the cut-off tool into action. We leave for the present the portion *s t* of the cutting-off cam 16, Fig. 5, used when machining takes place. The portion *r s* of the cam that moves the cut-off rest up to the job quickly had better be considered, and what applies to this cam, equally applies to the portion *n p* on the forming cam 15, and *u v* on the returning cam 17. It is usually necessary to move the cut-off rest over the idle portion of its travel for the least possible movement of the disk. In the present case it is necessary to move the cut-off rest after the forming is finished to where the cut-off commences, and again after the cutting is finished to the mid-position, for the least possible movement of disk, and so save a lot of idle or waste space on the turret slide cam drum. In the case of the forming cam it is of less account as there is a lot of space on the drum previous to where the forming starts that is used for returning the finish drill and running down the steady, and this space can be utilized when running the forming tool up to the job. The effective leverage *x* should be kept as long as possible, but of course the shorter the effective leverage the quicker the slide moves. Another point to watch when working on these quick portions of the cams is that the opposite lever clears the cam it is leaving.



Industrial Press, N. Y.

Fig. 8.

Having settled that portion of the cutting-off cam 16 that moves the cut-off rest up to the job, the portion *s t* that is used when machining can be considered. It is required to cut off ⅝-inch deep at 200 cuts per inch; and allowing an extra ⅛-inch, this makes ¾-inch total depth. The number of revolutions of the spindle, when on the fast speed, to one of the drum equals 4,444; the revolutions of spindle to cut off ¾-inch deep at 200 cuts per inch $= \frac{200 \times 3}{4} = 150$. Then using the same method as described for the forming cam, the number of degrees moved through by the drum while the spindle makes 150 turns on the fast speed $= \frac{150}{4444} \times \frac{360°}{1} = 12.1°$, say 12°. This portion of the cam 16 is set out as shown in Fig. 5.

Fig. 7 shows the cutting off finished and the forming lever *L* about to return the cut-off rest to the mid-position. Fig. 8 shows the cut-off rest back in the mid-position.

The disk cams have been dealt with at some length so that their action might be thoroughly understood. When laying these out it is only necessary to draw the forming lever *L* and the cut off lever *M* in the mid-position, and at the "finish forming" and the "finish cutting off" positions; then to draw the cams on a piece of tracing paper on the top, which can be moved round for the different positions of the levers, in a similar manner that the positions of the disk and levers are shown in Figs. 5, 6, 7, and 8.

These cams can now be referred to the turret slide cam drum in the following manner. From the "start forming" to the "finish forming" the cut-off disk moves through 18½°; then the equivalent distance on the drum is $\frac{65.97'' \times 18.5°}{360°} = 3.39$ inches, which can be laid off on the drum from the "start forming" line. Again, the number of degrees moved through by the disk from the "start forming" to the start cut off is 59°; the equivalent distance on the drum is $\frac{65.97'' \times 59°}{360°} = 10.8$ inches. This can be laid off on the drum from the "start forming" line, other positions being obtained in a similar manner.

Having laid down all the cams, it is necessary to see that the cutting-off tool is well clear of the job before the chuck commences to open. Possibly it will be found that it is not, in which case the cams on the turret slide cam drum and cut-off disk should be looked through to see if any space on the drum can be saved. If this is insufficient, a different size of feed pulley *C* should be used.

No hard and fast rules can be laid down as to what angles should be used, as these will vary for different machines owing to the difference in details, and hence each machine must be considered independently.

* * *

MACHINE TOOLS AND MACHINE SHOP PRACTICE DURING THE TEN YEARS FROM 1890 TO 1900.

Regarding the development of machine tools and machine shop practice during the ten years that elapsed between 1890 and 1900, Mr. Edward H. Sanborn says, in Bulletin No. 247 on Metal-working Machinery, that progress has been marked by the following significant features:

1. The automatic and semi-automatic principles have been extended to new and larger classes of work than before.
2. The forming tool has become a recognized shop appliance.
3. The "oil-tube drill" has been developed from an exceptional to a regularly used tool.
4. Compressed air portable tools have been developed substantially from the beginning.
5. The application of the power press has been greatly extended.
6. Electrical driving has come into general use.
7. The system of heavy portable machine tools in conjunction with a massive iron floor plate has been originated.
8. The grinding machine has been largely increased in size, power, and extent of use.

Closely related to machine shop practice, though scarcely coming within mechine-tool classification, may be mentioned:

9. The development of traveling cranes.
10. The origin of high-speed steels for cutting tools.

These lines of development may be discussed briefly in the above order.

1. The extension of the semi-automatic principle, as illustrated by the hand-operated turret lathe, has been chiefly toward the execution of larger and heavier work, while the use of the entirely automatic turret lathe has been not only in the same direction, but has been adapted to entirely new classes of work. An illustration of the first line of development is found in several types of turret lathes which, although employing certain methods of attacking the work which were not known before their advent, is nevertheless essentially an extension of the turret principle to larger work than had before been done by it.

An illustration of the second line of development is to be found in the "magazine feed" full automatic turret lathe. Prior to the advent of this machine, the full automatic machine had been employed exclusively for making screws, studs, etc., from bar stock which was fed to the machine through the hollow live spindle, the pieces being first turned, threaded, etc., and then cut off, when the bar of stock was fed downward and another piece made, the operation continuing until the bar of stock was used up. The new machine applied the automatic principle to the machining of parts which, when in the rough, were already in separate pieces, i.e., castings or drop forgings. In doing such work the finished piece must be taken bodily from the machine and a new rough piece inserted. This is a fundamentally different operation from merely pushing a long bar of stock to a new position. It is effected by the "magazine feed," the magazine being filled with rough parts by the workman, these parts then being automatically inserted in the machine and removed therefrom when finished. The line of development exemplified by the machine first mentioned belongs to the entire decade, while that exemplified by the other belongs to its close.

Another line of development in this class of machines which should be mentioned is the use of multiple spindles, whereby the output of certain classes of work is very greatly increased—to the extent of a threefold ratio in some instances. An outgrowth of this development has been the making of small brass screws and similar articles without money consideration, the chips cut off in making the articles being accepted as sufficient payment for doing the work.

2. The use of the forming tool goes back of the decade under consideration, but its use prior to 1890 was chiefly, if not entirely, for the making of articles from very soft composition castings, examples of the work being seen in the caps of salt and pepper boxes. The application of the principle to harder material came about in connection with the bicycle industry, one of its final applications to articles of steel being in the making of bicycle-wheel hubs. If this is not the first application of the method to steel, at least it familiarized the mechanical public with it, and from this it has come to have quite an extended application.

3. By the "oil-tube drill" is meant a drill—either flat or twist—having an oil tube or oil channel leading to or near its point, through which a current of oil may be forced to lubricate and cool the cutting edges and to wash away the chips. It is used chiefly for deep drilling in steel and usually in machines of the lathe class, in which the work revolves against a fixed drill, although the arrangement is also used in upright drilling machines, in which the tool revolves. The history of this appliance is almost exactly parallel to that of the forming tool. It was known and used to a limited extent before 1890, having first been used for the drilling of gun barrels; but its more extensive application must, like that of the forming tool, be credited to the bicycle industry, the development of the two tools being, in fact, simultaneous. The forming tool having been successfully applied to the machining of the outside of bicycle-wheel hubs, it was found that a portion of the gain due to its faster action was lost because the simultaneous drilling of the hole required more time than the work upon the outside of the piece. This condition of things led to the adoption of the oil-tube drill for this work, and from this application the use of the appliances has become widely extended. Of the two, the oil-tube drill is no doubt the more important. The increasing use of hollow-spindle lathes and automatic and hand-operated turret lathes, in which the spindles are necessarily hollow, not to mention milling and other machines having hollow spindles, has given a wide field of usefulness to this tool.

4. The numerous class of small and unpretentious pneumatic tools which came into prominence and extended use during the decade under review may, it is quite possible, be looked upon as the most important single machine tool development of the decade. Of these, the first in order of importance as well as of time is the pneumatic hammer. Originally devised as a substitute for the hand hammer and chisel in the machine shop and in stone-cutting, it has extended its field of usefulness to many other fields, and is to-day an indispensable tool in shipbuilding and in the erection of steel-frame buildings. Of the general class of compressed air tools, the next in importance to the hammer is perhaps the rotary drill, which, in its numerous forms and applications has introduced mechanical power in place of hand labor for classes of work to which the application of mechanical power seemed almost hopeless. These and numerous other applications of compressed air to machine and similar work stand almost wholly to the credit of the decade 1890 to 1900, the hammer alone having been in use prior to 1890.

5. The great expansion in the use of power presses which has taken place during this decade must be credited largely to the growth of the electrical industries. The advent of the laminated armature for electric generators and motors called for accurately-made punchings of sheet metal of a size and in numbers previously unknown. The power press furnished the natural method of making them, and in its development the capabilities of the machines were demonstrated as they had never been before.

6. The electric motor as a means of driving machine tools was first seriously proposed about or shortly before the middle of the decade, and was generally looked upon by mechanical men as a fad of the electrician. The innovation nevertheless obtained a foothold, and advantages which were not foreseen were found to attend it. It has become the accepted method of driving factories (*a*) which are composed of many departments, the flexibility and economy of the system in distributing power over a considerable area from a central station being here the factor of dominating importance, and (*b*) those which are of a nature requiring tools and machines to be located at considerable distances apart, especially if they are also to be intermittently operated. It is also making rapid progress in machine shops, to which the above limitations do not apply, though in such applications opinion regarding its merit is still unsettled. A leading controversial point is the attachment of individual motors to each machine tool *versus* group-driving of several machines through a single motor and a line shaft. There are well-defined conditions under which each method is suitable, but there is still a wide intervening field of debatable ground. As a matter of fact, in this field the individual motor is making rapid progress—more so perhaps than can be readily explained.

7. Like the increased development of power presses, the floor plate portable tool system of attacking heavy work must be credited to the electrical industries, which in this instance, curiously enough, furnished both the work for which the system was first devised and the means for doing the work. It was to the machining of the ring or magnet frames of large electric generators that the system was first applied, and the electric motor supplied the only practicable method of driving the tools which form part of the system. The system has not yet found much application outside of electrical work, although a beginning has been made, and this growth will doubtless continue.

8. The grinding machine was first devised during the past decade as a means of doing superior work, but it was not long before it became evident that it was a source of economy as well as a means of securing superior workmanship. The full significance of this was, however, slow to be realized, and it was not until toward the close of the decade that the movement began toward a very marked increase in capacity, weight, and power of the machine.

9. In no feature of machine shop practice has there been greater progress in American shops during this decade than in the provision of crane facilities. Twenty years ago the absence of these facilities was a national reproach, but to-day there is undoubtedly better crane service in the United States than exists elsewhere. This development is to be credited to the electric motor, without which it is at least doubtful if the present stage of progress could ever have been reached. The mere transmission of the power required for cranes of present capacities by the old square shaft or flying rope would be a serious problem. Electricity furnishes, in fact, an ideal method of driving cranes, and the necessary installation of an electric plant for operating cranes has no doubt greatly furthered the adoption of electric power for other purposes.

10. Within the last few years discoveries have been made whereby certain classes of tool steel are made to endure cutting speeds which before were impossible. Like all other

useful things these steels have certain limitations and it is too early to state definitely what their ultimate economic importance will be. It is reasonably certain, however, to be considerable.

* * *

STANDARD EQUIPMENTS FOR MOTOR-DRIVEN PLANERS.

The G. A. Gray Co., manufacturers of planers, Cincinnati, O., have devoted a great deal of attention to the arrangement of motor drives for their machines, and have so systematized the methods for motor attachment as to have certain standard forms of brackets and connections between motor and planer adapted to all requirements. They are prepared to furnish three different types of standard drives for their spur-geared planers and two types for their spiral-geared planers.

A motor drive is made up of two parts, the electrical, or motor equipment, and the mechanical, or supplementary equipment, which latter includes the countershaft, pulleys, etc., with brackets cast on the housings, and shelf fitted to same, for supporting the apparatus. These latter are so designed as to be adapted to any type of motor that may be applied to the planer, so that it will not be necessary to prepare special drawings or patterns to meet the needs of different customers. Thus, if a customer orders a planer and states that he wishes to use a motor of certain make and which runs at certain speed, the particular style of drive adapted to the specifications is selected and the brackets are cast on the housings from the regular patterns in stock.

The three types of motor drive adopted for the spur-geared planers are as follows:

The silent chain-geared drive, Fig. 1 on the opposite page;
The direct-connected drive, Fig. 2;
The motor-belted drive, Fig. 3.

The two types of drive for the spiral-geared planers are:

The self-contained drive, illustrated in Fig. 4;
The motor-belted drive, illustrated in Fig. 5.

It will be noticed that the silent chain-geared drive, Fig. 1, is entirely self-contained, and permits the use of a medium or high speed motor, instead of the more expensive slow speed motor required for the direct-connected drive shown in Fig. 2. The countershaft is mounted on a shelf, bolted to brackets cast on the housings, and is driven by means of a Renold silent chain, from a motor mounted close to it on the same shelf.

With such necessarily short center distances, a belt might not work satisfactorily, and spur gearing might gradually wear noisy, on account of the difficulty of maintaining the permanency of alignment necessary to smooth and quiet running.

The silent chain may be run slack and cannot slip like a belt. It does not require fixed centers, as is essential with gearing. It is, therefore, peculiarly adapted to this type of drive.

The direct-connected drive, Fig. 2, is also entirely self-contained. The motor is mounted on a shelf, bolted to brackets cast on the housings, and the driving pulleys are placed on the motor shaft; thus making it possible to belt directly down to the planer.

This type of drive makes it necessary that the motor run at countershaft speed; and the motor-shaft must be extended to carry the driving pulleys, and the pulley which operates the power-elevating device. In order to relieve the motor bearing from the undue strain, an independent outside bearing is furnished.

The motor-belted drive, as shown in Fig. 3, permits the use of a medium or high-speed motor, the pulleys being so proportioned that the countershaft will be run at regular speed. This countershaft is mounted on a shelf, bolted to brackets cast on the housings, and is driven by belt from a motor placed on the floor, or in a more convenient location.

In the self-contained drive, as applied to *Spiral*-geared planers, and shown in Fig. 4, the countershaft is mounted on a shelf, bolted to brackets cast on the housings, and is driven by belt, from a motor mounted on same shelf.

This type of drive permits the use of a medium or high-speed motor, the pulleys being so proportioned that the countershaft will be run at regular speed; and the center distances are such that a belt drive is perfectly practicable; the motor being provided with means for taking up the slack of belt.

In the motor-belted drive for spiral-geared planers, Fig. 5, the countershaft is mounted on a shelf, which is bolted to a bracket cast on the front housing, and which is furthermore supported by an outboard column resting on the floor. The countershaft is driven by a motor placed on the floor alongside of the planer, or in a more convenient location. This type of drive also permits the use of a medium or high speed motor.

When a complete motor equipment is furnished by the planer manufacturers, the outfit includes a multipolar iron-clad motor, a universal motor-starting rheostat with automatic release; overload and current indicator; main switch and covered fuse connections. The rheostat, indicator and switch are mounted on a slate slab, and wired complete. It is therefore only necessary to fasten the slab in position and connect the binding posts with the line wires and motor, in accordance with the diagram sent with each outfit. If a customer prefers, however, he may supply the motor equipment himself and the builders will then furnish only the supplementary equipment, which would include the brackets, shelf, etc., as mentioned above.

Where a customer orders a planer complete with regular countershaft, but intends at some future time to apply electric drive, the housings can be prepared by casting on the brackets, ready to receive the Standard motor-shelf. The motor power required for driving a planer obviously depends upon such a variety of conditions that the company generally recommend such powers as they consider ample for average service. It should be remembered, however, that the amount of power necessary at the moment of reversal, and for the "quick return," is vastly in excess of what is required to merely drive a planer while cutting, and for that reason it is advisable to provide a larger motor than the actual work would require.

* * *

MAKING SCREWS WITHOUT WASTE OF MATERIAL.

The latest development of automatic screw machinery about which we have been informed, is a machine that makes machine screws from a coil of wire without entailing any waste of the material. That is to say, the product from a coil of wire, weighing 50 pounds, would be 50 pounds of screws. This surprising result is obtained, of course, by the avoidance of all tool cutting action except that necessary to separate the screw from the stock, the screw being formed, head and all, entirely by swaging and rolling. This machine which is being perfected by a Springfield, Mass., inventor, first straightens the wire from the coil, then the end is caught between swaging dies of peculiar construction and given a rapid series of blows which form the body of the blank and partially form the head. The body of the blank which is to be threaded, is swaged to a smaller diameter to allow for the increase of diameter due to rolling the thread. After the first swaging operation, the blank is cut from the wire and thrust into a die where the head is fully formed, and the slot for the screwdriver punched at the same time. This punching action removes no stock, but expands the head so that it fills the die. After this has been done the blank is picked up and carried between two hardened threading rollers which roll the thread and complete the making of the screw.

Just what future there is in store for such a machine, we would not care to predict, but it appears that there is always a field open for any machine that effects a saving in time, material or attendance. When all three features are combined in one machine, its advantages seem obvious. The first machines for making wire nails, wasted a small portion of the wire between each nail in cutting the points. This waste, we believe, has been eliminated in the later machines and the economy resulting is of considerable importance, making almost the difference between profit and loss at times in the past.

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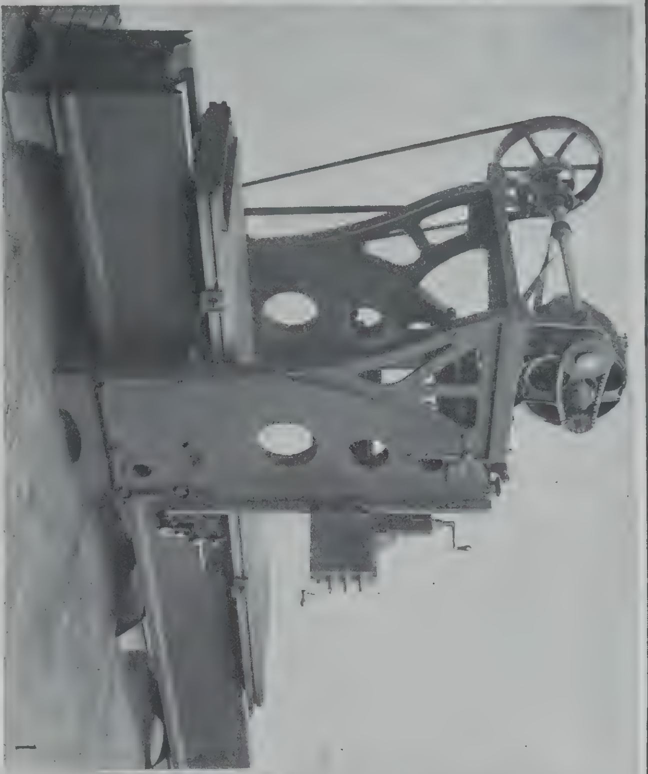
It is stated that the largest steel plate ever rolled was one recently turned out by the Parkgate Works, England; it is 30 feet long, 10 feet 6 inches wide and seven-eighths of an inch thick.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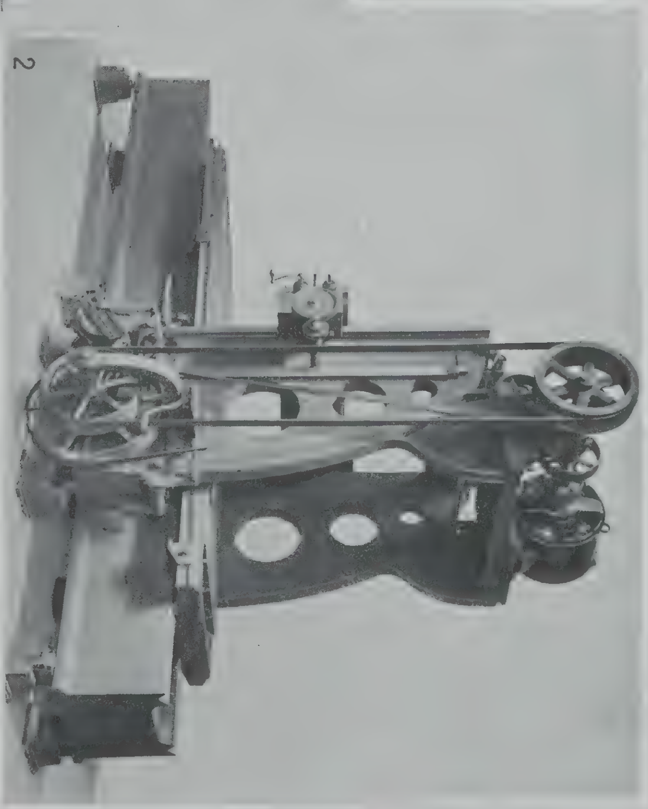
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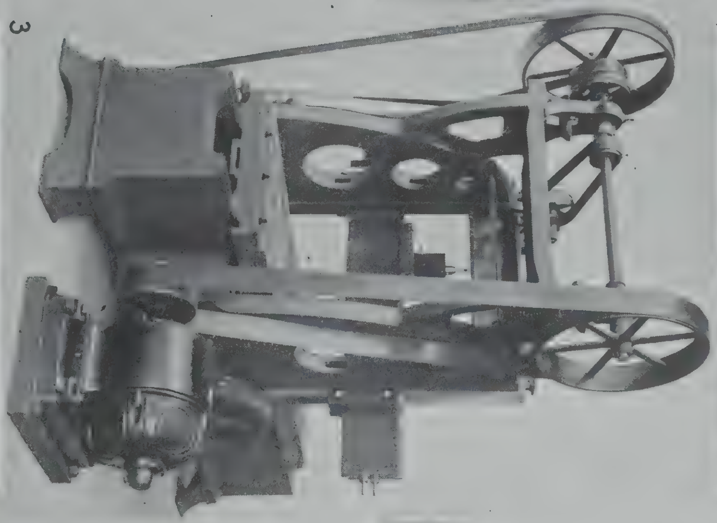
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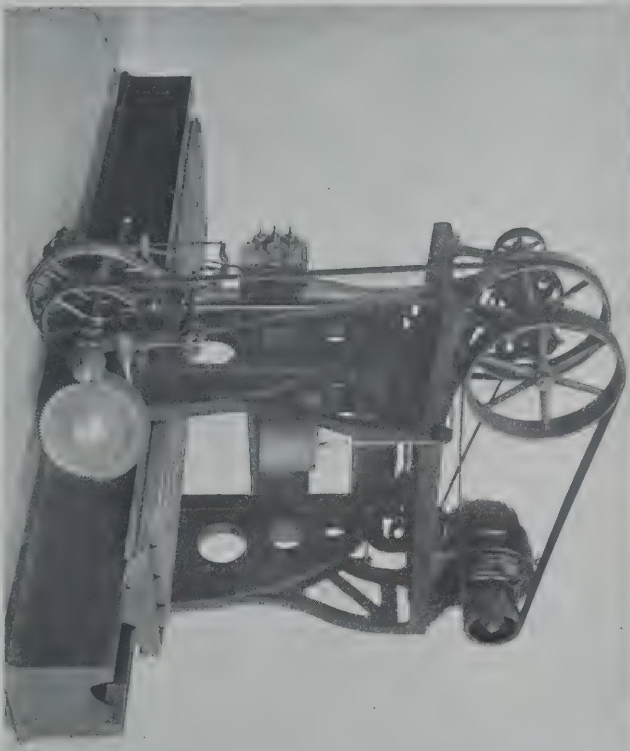
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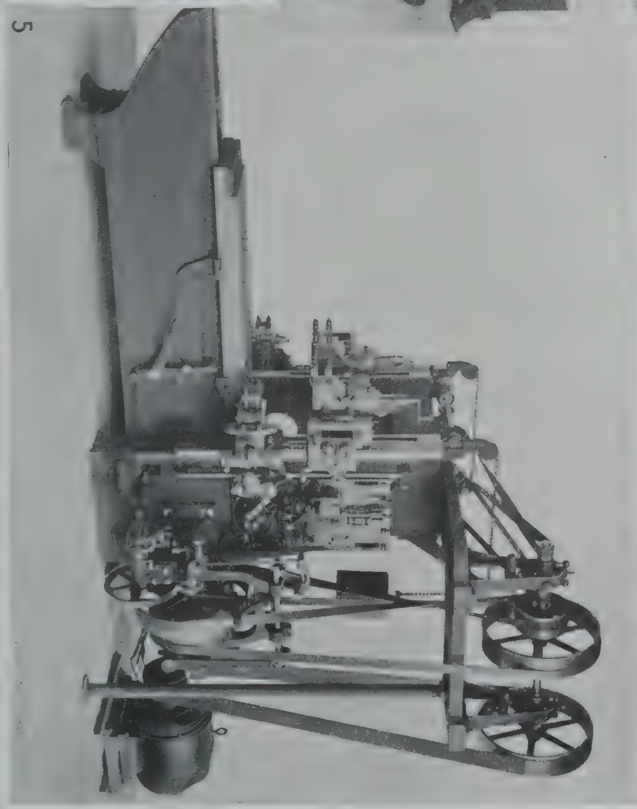
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Standard Motor Drives for Planers adopted by the G. A. Gray Co., Cincinnati, O.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

9-15 MURRAY STREET, NEW YORK CITY.

CHICAGO—1462 MONADNOCK BLOCK. BOSTON—620 ATLANTIC AVE.
PHILADELPHIA—MACHINERY FLOOR, THE BOURSE.

SUBSCRIPTIONS.

SHOP EDITION, $1.00 A YEAR. TEN CENTS A COPY.
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FEBRUARY, 1903.

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ENVIRONMENT IS RESPONSIBLE.

The reasons for the success of American competition abroad and the avowed "supremacy" of the American workman have been investigated by the so-called Mosely commission of English workmen. The commission was composed of secretaries of 23 leading trade unions, who made an extended trip through this country, visiting important plants like the Schenectady Locomotive Works, the works of the General Electric Company, the Niagara power plant, the steel works of Cleveland and Pittsburg, the Cramp and Baldwin works of Philadelphia and many establishments in other fields of industry.

In a recent number of the *Outlook* certain features of the report of the commission are touched upon by Mr. George Lynch, a London correspondent intimately acquainted with the work of the visitors. He mentions—what we have already contended in these columns—that the mechanic is very much the same man on either side of the Atlantic, and that it is his environment, rather than his nationality, which stimulates or retards his progress. In America he is more productive because his influences are such as to make the product of his labor much greater than when under the more conservative and less favorable conditions which exist abroad.

To begin with, American climate is invigorating and conducive to work. The American workman lives in better surroundings, and works under better and more healthful conditions in the factory. He is influenced by the natural tendency to push work at its most rapid rate, devising where possible, mechanical ways to do this. The delegates repeatedly remarked that American mechanics do not seem to work harder than those in England, but they accomplish more because they make their minds save their hands. They make the machine take the wear and tear, if they can.

In this country, where so many factories are of recent construction, it is not surprising that they should be filled with new machinery; but the delegates were apparently surprised to find the scrap pile heaps so large in the vicinity of the older works, indicating that the American is disposed to throw out any machine almost as soon as it has been improved upon. Not the least important phase of the subject, however, is the fact that the workman in America indulges less in alcoholic beverages than the English workman, statistics showing that the consumption of these is more than twice as great per capita in Great Britain as in the United States.

Incidental to the trip should be mentioned the expressions of surprise on the part of the Englishmen that the manufacturers of America should have so universally kept "open house" for them. It was well known that no body of American workmen, skilled in the various arts and who would be quick to pick up ideas, could investigate the ways and methods of English shops, with anything like as great a degree of freedom. In other words, the country which is acknowledged supreme in its trade accomplishments has fewer secrets to hide than its less aggressive rival. May it not be that the same rule holds in respect to individual firms? We not only believe it does, but know that it does in many instances.

* * *

AN APT PHRASE FOR THE MECHANIC.

The veteran Senator Hoar of Massachusetts, in his recent speech upon the trust problem, drew a very pretty picture of Worcester, Mass., as a mechanic's home and alluded briefly to the many inventors who had at one time or another lived near that city. Eli Whitney, who doubled the value of every acre of land on which cotton grew, was born near Worcester; so was Bigelow, the inventor of the carpet loom; and so, also, was Blanchard, the inventor of the lathe for turning irregular forms. Elias Howe, the inventor of the sewing machine, was born and lived near Worcester, and the card clothing machine and the envelope machine were also invented or developed in that city. In referring to the results that have come from the work of such mechanics, the Senator very aptly said that "it was not water power or steam power or electricity that wrought this miracle; it was brain power."

This is a good phrase to remember and to live by. While plenty of men get along without brain power, they are generally men who are held up by props of some kind or other, and if the props were knocked out they would fall with them. Even the great trust, of which the Senator spoke, with all its wealth and untold resources cannot get along without brain power, which it will always have to pay for.

Especially would we commend the phrase to the young mechanic. Do you wish to succeed in the world? It is very easy to enumerate the things that *will not* contribute to that end. No mechanic will advance because he does not do his work intelligently; nor because he does not study; nor because he does not cultivate the power of observation or the habit of reading the technical papers, which tell him what others are doing in his own field of work. In short, no man ever succeeded because he did not use his brain. Not all mechanics can rise to the distinction of Eli Whitney or Elias Howe, or perhaps to any distinction at all. But it is morally certain that great mechanics like these would never have been heard of if they had not used their brains. Whatever may be the industrial conditions of the country through the great movements of modern times, let it be remembered that brains are the one staple commodity that the world cannot do without. The moral is to cultivate and develop the brain as well as the muscle and the future will take care of itself.

* * *

EFFECT OF GAS ON COAL TRANSPORTATION.

One of the great changes possible in future industrial development may be the establishment of great gas-making plants in the near vicinity of coal mines, and the conveying of the gas to cities by immense pipe line systems. This would largely do away with the present wasteful and expensive method of getting fuel to market by hauling coal in railway cars. A modern steel coal car weighs forty per cent. as much as the coal it can carry, and the car has to be hauled both ways. This, with weight of the locomotive, makes it practically about the same as hauling a ton of dead weight one way for each ton of freight. The proportion of dead weight hauled is usually much greater, especially when older equipment is used. The principal expense attending the movement of gas in mains is entailed by the pressure necessary to force it through, which would have to be developed by pumps. In the past, however, the cost of making gas has been a bar to its competing with coal in the manner outlined, so the only places where gas is generally used for fuel are those where natural gas is cheaply supplied. The price of natural gas varies in different localities, being from ten to fifteen cents per 1,000 cubic feet in some western Pennsylvania towns. In the future the conditions will be different, if a gas-making process developed by a Pittsburg mechanical engineer is as successful as reported. By this process it is claimed that fuel gas can be made at a cost of $.0108 (1.08 cents) per 1,000 cubic feet. A ton of coal produces by the new process 25,000 cubic feet of gas having a heat efficiency of 560 B. T. U. per cubic foot at a cost of $1.43. The by-products are 600 pounds of coke, 10 gallons of tar and sufficient ammonia liquor per ton to reduce the cost to the extremely low figure quoted. Even if there was no market for the by-products the cost of the manufactured gas would still be extremely low.

* * *

ELECTRIC RAILROADING.

In the last number of the *Technology Quarterly* is an article by Prof. Louis Duncan upon long-distance electric railroading that gives an interesting survey of electric traction as the problem now presents itself. Prof. Duncan is an engineer of wide experience, and has recently been appointed professor of electrical engineering at the Massachusetts Institute of Technology. He does not see the doom of the locomotive as plainly as perhaps some of the more enthusiastic members of the profession, for he believes there are several important factors that will tend to retard the progress of electric traction between distant points, especially with the through-train service of the leading roads. He contends that for through service a single car or even two cars are not enough to give the comfort to which the traveler is accustomed. This requires heavy trains of a number of cars, and even for a certain class of suburban traffic where a large amount of traveling is concentrated at certain hours, heavy trains must be used, requiring a great deal of power for each train.

In the transportation of freight, also, the tendency is toward heavy trains, because the minimum cost is attained with the maximum weight of train. The average train load on the Pennsylvania Railroad has increased about 75 per cent. in twenty years, and the capacity of the cars is over 100 per cent. Under these conditions he contends that continuous-current motors, receiving current either directly from a central station or from substations, are not applicable. The possibilities of congestion of traffic, especially in freight transportation, would make it necessary to have the capacity of substations enormous as compared with the average power required on the line, which would involve an immense increase in the original investment and some increase in the operative expenses.

Another difficulty is in the large amount of switching to be done, much of it of a complicated nature. If electricity is to be used in terminals and freight yards, a locomotive must be designed which is economical at all speeds, and which is under perfect control, and current must be supplied to these locomotives by some means which will not endanger the lives of the train hands. Railroading is dangerous enough as it is, and any additional source of danger must be avoided.

While the position of Prof. Duncan is very well taken, supposing that future railroading operations on electrically-equipped lines were to be conducted as they now are on steam railroads, it seems that this would be a mistake and directly against the tendencies of electrical operation (as manifested in passenger traffic, at least) which are, to run short trains and many of them. By doing this the public is better served and earnings increased without at the same time disproportionately increasing the operating expenses. The same should hold true to a large extent with freight traffic. Because we are used to having freight cars take a week or more in going from New York to Chicago, it is no sign that this is the proper condition of affairs or that it is one that will always exist in railroad operation. Long heavy trains necessarily mean slow movement of freight with possibly a minimum expense for wages of the trainmen; short trains mean quick freights and a slight increase per ton mile in wages, it is true, but the gross and net earnings would undoubtedly be greatly increased. The road bed of a railroad earns interest and dividends only while trains are passing over it and cars earn only in proportion to their mileage. If a freight car makes the round trip from New York to Chicago in a week, it earns just double what it does when making the trip one way in a week, and fewer cars are required for the same volume of freight. Without going into further argument in the matter it seems to us that the future of railroading lies more in the direction of shorter trains at high speeds, both for passenger and freight service, than in following the present trend with steam locomotives as the motive power.

* * *

NOTES AND COMMENT.

In his diary for 1843, Samuel F. B. Morse wrote: "The inference is that telegraphic communication on my plan may with certainty be established across the Atlantic. Startling as this may seem now, the time will come when this project will be realized." Yet this was only sixty years ago and men who were then old enough to have laughed at such a suggestion have lived to witness wireless communication across the ocean.

* * *

The *Philadelphia Record*, in a department devoted to scientific and mechanical notes, reproduces a cut of the motor-driven grinders manufactured by the Ransom Mfg. Co., Oshkosh, Wis., which have the motor armature directly on the grinder spindle, with the following description: "The familiar old grindstone is growing out of date and its place is being taken by the piece of machinery shown above. The stone wheels are driven by an electric motor encased in the base of the machine." Comment is unnecessary.

Some small work is not thought much of, and the doers of it are apt to receive scant consideration. Never despise, however, the maker of the small paragraph in a dire emergency to fill the corner of a page. Some of the quickest work of the editor is often done in those corners, and no wonder it does not always match what precedes it.—*American Machinist.*

There are notes and notes. The foregoing filled "the corner of a page" and was probably written in "dire emergency." A certain religious paper, so we are informed, has a stock of short prayers on hand, ranging from half-a-dozen to a score or so of lines in length, ready to be set in type for any and all occasions when a note is required to fill a certain space. But it is seldom that a technical editor has to practice sacrilege to fill his columns. There are usually enough pertinent facts at hand to supply the material for pithy notes, and it is frequently a matter of surprise to find that the notes published in MACHINERY bring numerous inquiries to this office, sometimes, in fact, more than the longer articles. This would indicate that some of the "small work" of the editor receives its fair share of attention, and we trust that the prayers of the religious editor may be answered as frequently.

As an illustration of what can be done with the new tool steels now appearing on the market, Prof. J. J. Flather, in an address before the Association for the Advancement of Science, stated that he had recently seen some steel locomotive driving wheels which had been turned in two hours and forty minutes, whereas the regular time previously had been not less than eight hours, with the old steel. Even better results might have been obtained, but the belts would not carry the load. Prof. Flather also related an anecdote to show how the tendency to increase the number of compressed air devices in machine shop work has sometimes led to extremes, and that in many cases the work could have been done just as cheaply by hand. The case in point was an apparatus that at one time was in use on one of our prominent Western roads. It was a sort of portable crane hoist which could be fastened to the smokestack of a locomotive, whereby one man could lift off the steam chest casing. The hoisting apparatus weighed about twice as much as the steam chest and took three men to put it up. When piece work was adopted two men easily lifted off the steam chest and this "labor-saving device" was relegated to the scrap heap.

A NEW INTERNAL COMBUSTION ENGINE.

LARGE HORIZONTAL GAS ENGINES DESIGNED BY THE WESTINGHOUSE MACHINE CO.

Much interest has of late been aroused by the exhibition abroad of numerous makes of high-power engines of the internal combustion type, and subsequent reports concerning their probable manufacture in America. Although much more attention has been devoted to this type of prime mover abroad, and its development has therefore been more marked, it is noteworthy that American manufacturers have in the meantime been conducting operations along this line with the result that internal combustion engines of American design and American manufacture, in sizes as high as several thousand horse power, are in evidence for service as exacting and severe as that for which the high-grade steam engine is now almost universally employed.

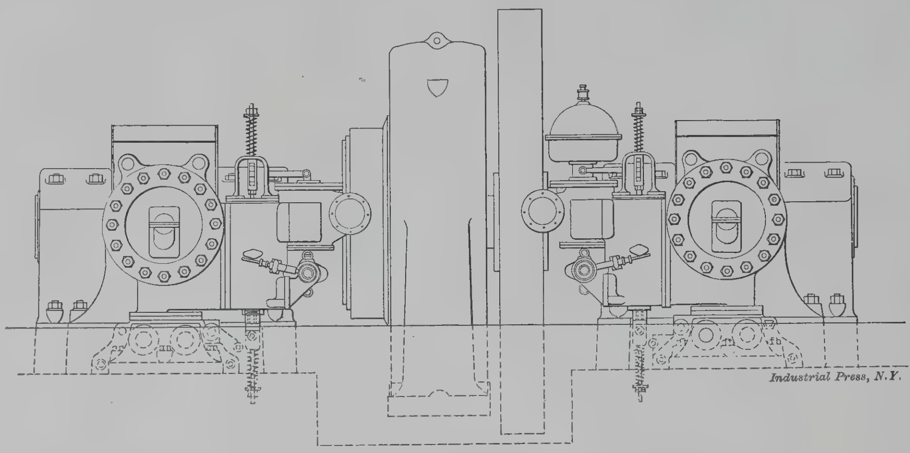


Fig. 1. End View of 1500 H. P. Double-crank Gas Engine, Direct Connected.

In the domestic field, few makers have ventured above 250 horse power, and none above 500 horse power, until recently, with one exception—the Westinghouse Machine Company, whose three-cylinder vertical single-acting engine is well known. The company have, however, been for some time engaged in developing the double acting engine, and are now prepared to build this type for powers ranging as high as 3,000 horse power. As this type of engine possesses features somewhat novel to those accustomed to the usual reciprocating engine design, a brief description may be of interest.

Fig. 3 is from a photograph of a single-crank engine of the new type, and Figs 1, 2 and 4 the general design of a 1,500 horse power double-crank engine, direct connected to a D. C. or A. C. generator.

The general design of the engine somewhat resembles that of the modern high-speed tandem compound steam engines in the arrangement of cylinders, frames, bed-plate, bearings, flywheel and generator. This resemblance is further carried out in the matter of crank effort. The engine operates on the four-stroke cycle, and as there are two double-acting cylinders an impulse is given at each stroke of the engine as in the steam engine.

The employment of the four-stroke cycle involves the important feature of positive scavenging which is here accomplished by the piston during its exhaust stroke, thus avoiding all weakening of the incoming mixture by the inert gases from the previous explosion, and insuring uniform operation. In all engines employing the two-stroke cycle, scavenging must be accomplished either by a special piston movement or by a blast of air from an auxiliary pump directed in such a manner as to force out the remaining burned gases, thus clearing the way, so to speak, for the incoming pure mixture. This latter method is the most practical, but has the inherent disadvantage of the incoming gas mixing with more or less of the air used in scavenging, causing a variation in the calorific value of the explosive mixture, which, for a gas of given constituency, should remain constant for the best results.

The Westinghouse design employs a mixture of unvarying quality, which is initially proportioned according to the nature of the gas used, but which remains constant under all conditions of load. As the loads upon the engine increase or decrease, a corresponding greater or lesser quantity of mixture is admitted to the cylinders, thus utilizing at all times an explosive mixture of maximum strength, resulting in

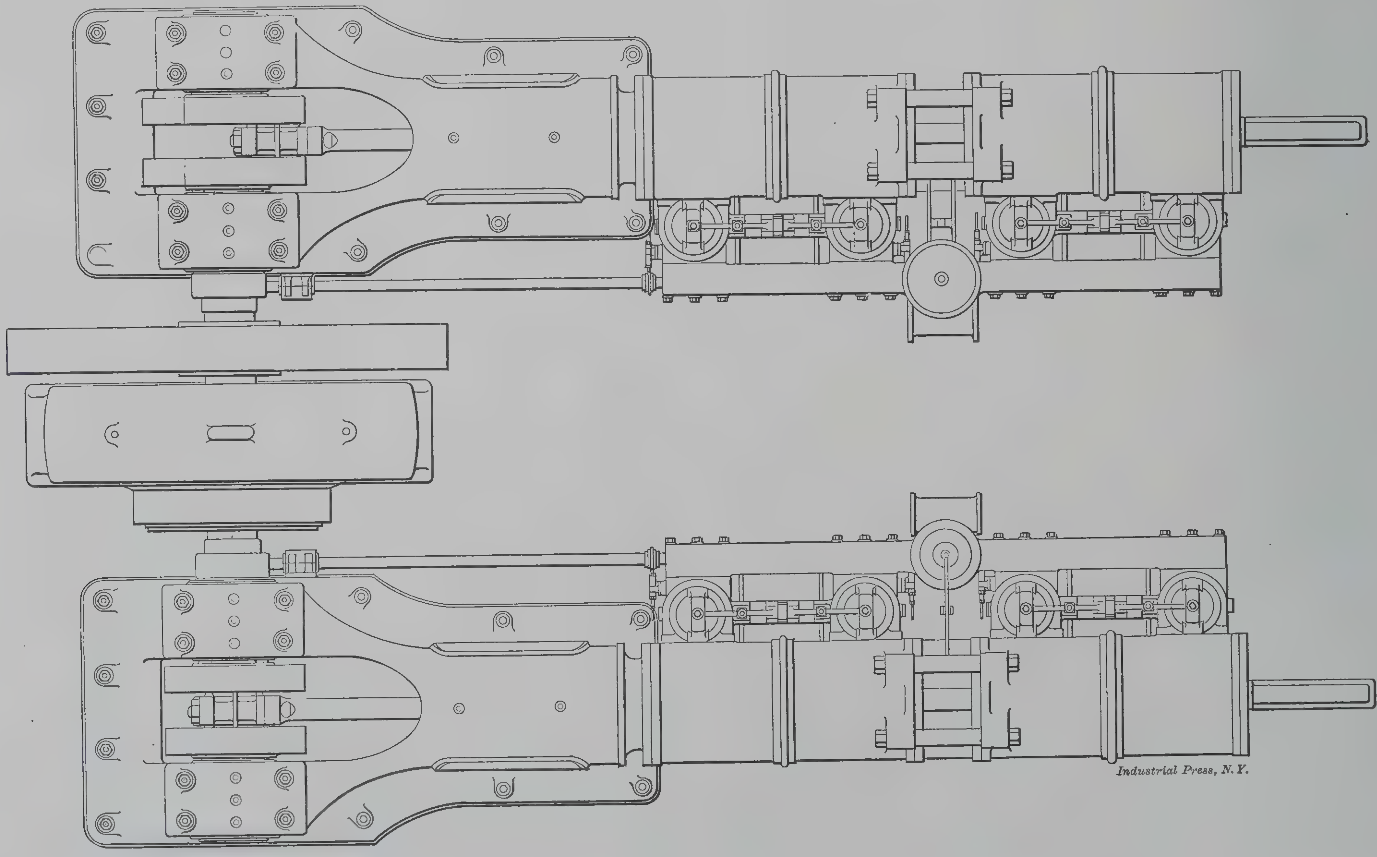


Fig. 2. Plan View of 1500 H. P. Engine.

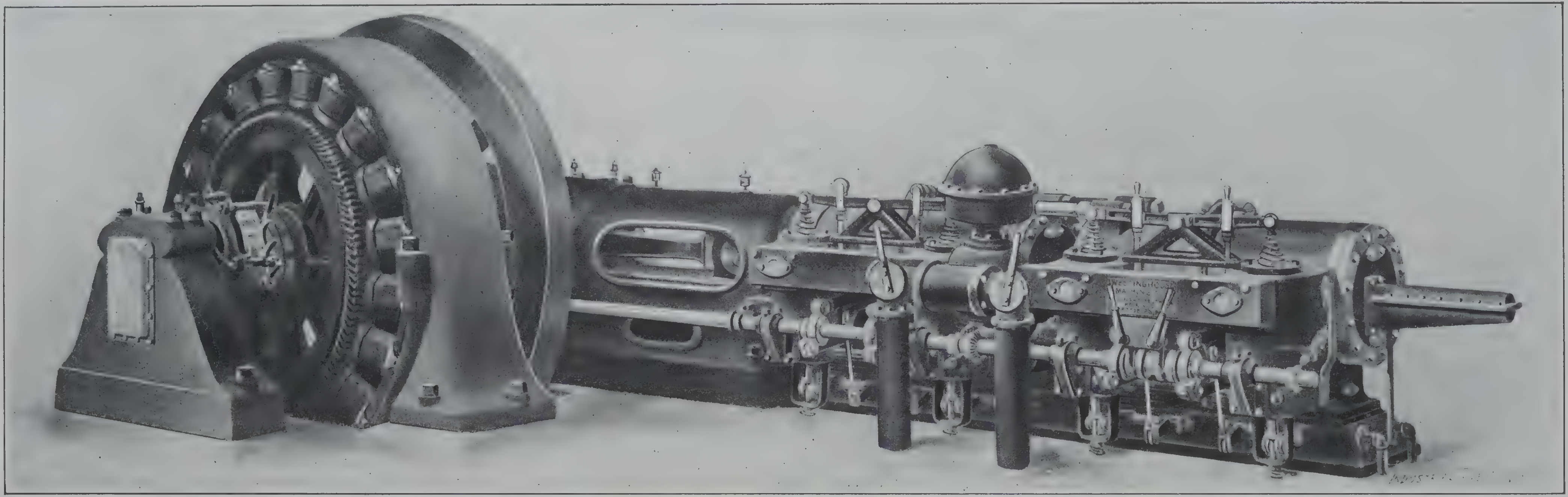


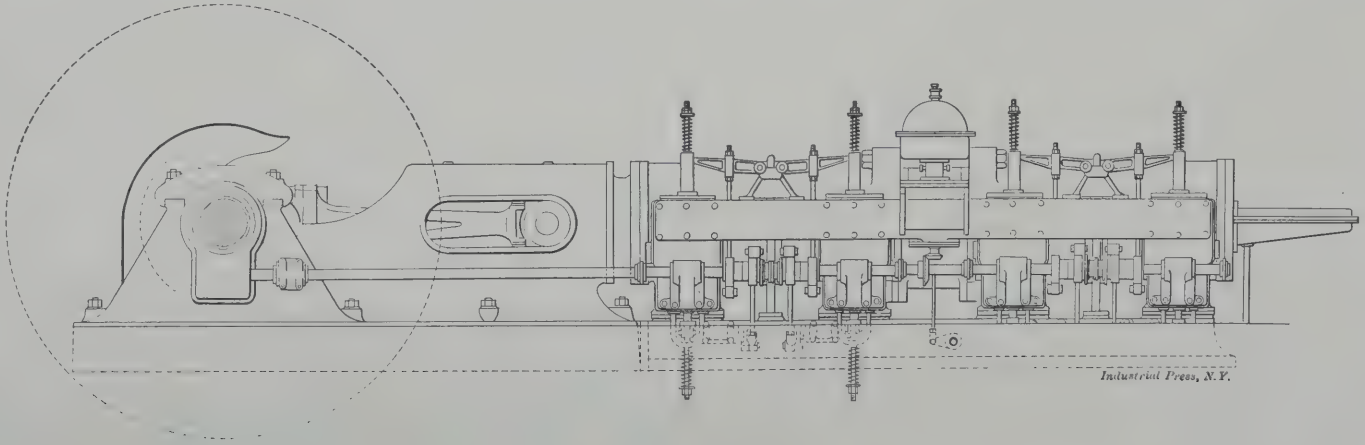
Fig. 3. General View of 750 H. P. Double-acting Single Gas Engine. (Photograph copyrighted.)

high thermal efficiency and economy of fuel. That this method is productive of the best results in engines of high power is apparent from the fact that reputable European builders, such as the Deutz Cockerill and Nurberg companies are abandoning the variable for the constant mixture method of governing.

The construction of the engine under description departs materially from the accepted European design and embodies many features of modern steam engine practice. The design of cylinders, pistons and valves, of course, departs materially from steam engine practice. The cylinders are double walled, with the outer walls split peripherally to permit independent expansion and contraction without placing the cylinder casting under stress. The two cylinders are united at the top by heavy tie-rods, engaging peripheral bosses, and at the bottom by a stout cast-iron distance piece. The rear section of the bed-plate which supports the two cylinders is cored hollow with a central dividing wall, and serves as a reservoir for incoming and outgoing circulating water. All connections are piped directly to these reservoirs, thus avoiding a large amount of piping about the engine. Through the bed-plate extend the four vertical exhaust pipes, which connect immediately below with an exhaust main. The exhaust passages leading from the valve chambers are cast integral with the cylinders, upon their sides, and are water cooled.

At the ends of each cylinder occur horizontal side ports, resembling straight steam ports, which communicate with removable combustion chambers, bolted to vertical bosses. The cylinders are closed by water-jacketed heads, split diametrically for facility in inspection of the interior, and the two halves are united with a ground fit, no packing being found necessary. This feature obviates the necessity for completely dismantling the engine for inspection.

The arrangement of valves and combustion chambers in the new design is simple and in marked contrast to the complexity of numerous European types. The latter still make use of the cylinder head or "breech end casting" for the location of combustion chambers, admission



Industrial Press, N.Y.

Fig. 4. Side View of 1500 H. P. Engine.

and exhaust valves, mixing and igniting chambers, and supports for the cam shafts, rocking levers, etc. This concentration of so many important functions in a single casting, which at best is already complex, is questionable. The arrangement shown in the accompanying illustrations accomplishes the same purpose at less cost and with less complexity. The combustion chambers are independent castings, with plain machined faces, circular valve liner seats, and cored out passages for circulating water. Both admission and exhaust valves, which are of the standard poppet type, operate vertically and with opposite throw. They seat under pressure, open by cam movement and close by spring pressure. The central space, closed by the admission valve above, and the exhaust below, communicates directly with the cylinder port before mentioned; the exhaust space with the exhaust passages on the under sides of the cylinder; the admission space with the supply pipe. This supply pipe is a rectangular cast-iron main extending along the entire front and provided with openings opposite each admission valve. It receives its supply from the governor chamber located midway between the two ends, this in turn communicating with a mixing chamber supplied on the one hand with gas, and on the other with air, through suitable valves. These two valves are shown in Fig. 4, and are provided with graduated indices, so that the exact proportions of gas and air may at all times be visible and under the control of the attendant. Each valve, together with its spindle and seating spring, is independently mounted, and by simply removing the bolts from the bonnet, the entire valve, seat and liner may be drawn out for inspection or replacement by another. Similarly, the igniters, which are of the "make and break" electrical contact type, are mounted in a removable plug extending into the combustion chamber through the side walls. The valve gear is of the cam and roller pattern, and is driven by a helical gear, engaging a similar split gear bolted around the main shaft. The entire gear may be instantly disengaged by a special trip coupling inserted on the driving rod.

The method of circulating cooling water is unique. This water enters a cavity in the crosshead by means of a flexible tube connection with the reservoir in the bedplate. It then flows througs the hollow piston rod to the forward piston, around which it circulates thence through the second rod to the rear piston; thence through a brass tail rod extending through the rear head and there empties into a cast-iron jacket bolted to the rear head and communicates with the hot water outlet pipe. Similarly cold water is conducted through suitable pipes to the cylinder jackets, thence to the jackets surrounding the exhaust valves and ports, and finally to the return pipe, emerging at a sufficiently high temperature for use in heating and drying coils, radiators, etc.

The engine pistons are constructed in two parts, with packing rings and babbitted bearing surfaces. They are secured in position on the rods by internal nuts and present plain convex surfaces to the burning gases. Piston rods are of forged steel, with bored water ducts. Between the two cylinders close fitting brass sleeves are used for packing, and split ring bushings in the outer cylinder head.

The engine is started by compressed air pumped into a steel reservoir during a previous run before shutting down. For this purpose a special disengaging gear is provided which isolates the rear cylinder. In starting, this air is admitted to the rear cylinder by the regular valve mechanism temporarily connected to the compressed air system and the explosion cycle in the forward cylinder is immediately started. The rear cylinder may then be thrown into action. Oiling is accomplished by steam engine appliances, such as sight feed cups, cylinder pumps, and oil rings for crank pins.

The engine is governed by a sensitive fly-ball governor of the standard design, protected by a circular housing. It operates a vertical piston valve supplying a fuel mixture of constant quality, but in quantities proportionate to the load.

The single crank engine is at present manufactured in sizes ranging from 150 to 750 horse power, and the double crank from 750 to 1,500 horse power. In the latter, the cranks are placed at 90 degree angularity, giving four impulses per revolution, and crank effort corresponding to that of the cross-compound double-acting steam engine.

It is of interest to note that several installations of this type of engine are in progress. The first will be at the works of the Consolidated Industries Company, Batavia, N. Y., which will employ 250 horse power single-crank double acting engines. A special coke and gas process, known as the Lowe, will be employed, yielding three products—metallurgical coke and coal and water gas, the former to be retailed and the two latter combined and used for power purposes. The second installation will be put into operation at the works of the Atlantic Refining Company, Philadelphia. The engines are double-crank, double acting, of 500 horse power each, and will operate upon a rich oil gas of approximately 1,200 British thermal units per cubic foot—a by-product of the refining process. Both these installations will be direct-connected to Westinghouse generators.

A third interesting installation at Hillburn, N. Y., will supply the entire Ramapo Valley with light and power from a new station now building for the Rockland Electric Company. This plant will also operate upon producer gas, using the Loomis-Pettibone process. The producer plant is located in a separate building and supplies water gas to the Ramapo Iron Works and the Ramapo Foundry Company for heating and metallurgical purposes, as well as power gas to the generating station. The electrical distribution system will supply power to local industries, as well as lighting for the Ramapo Valley, some fourteen miles in extent. The equipment aggregates 1,200 horse power, employing 350 horse power single-crank engines of the double-acting type, and a small vertical single acting engine for driving the exciter. Each main engine is direct connected to Westinghouse polyphase generators, arranged for parallel operation. This plant will be one of the first alternating current stations in the country to be operated from gas power.

A further and more recent instance of the confidence placed in gas power apparatus is that of the Potosina Electric Company, of San Luis Potosi, Mexico, a town of 70,000 inhabitants, situated at an elevation of about 6,000 feet above sea level, about 275 miles northwest of Mexico City. The town was formerly supplied with electric light and power from a D. C. steam-driven plant which passed into the control of the present company and has been converted to a gas power alternating current central station arranged for parallel alternation upon a single distributing system.

The plant has been laid out for five main units, an exciter unit, and a compressor, aggregating 1,225 horse power, and will also employ the Loomis-Pettibone process for generating a power gas of approximately 120 British thermal units per cubic foot, calorific value.

The four installations above noted are among the first applications of fuel gas to power purposes, and the advent of the modern high power gas engine should serve to open up an entirely new field in gas engineering. A number of power gas processes are now available, including the Loomis-Pettibone, Taylor, Mond, Otto Hoffman, Lowe, Dellwick, Fleischer and Dawson and the results obtained from installations now in service give every reason to believe that the gas-power station will shortly be much in evidence. At present three main and two auxiliary units will be installed, the remaining two units, each of 340 horse power, being added as required.

* * *

Modern Machinery reports that a peculiar affection has appeared in the glass windows of York Cathedral, England. The glass has become dull and fragile and filled with holes. Windows that have been in place for six or seven hundred years have lately been removed in order to arrest this curious form of deterioration. The trouble, which may properly be named a "disease," is ascribed to a fungus, but in what way it attacks glass is not yet definitely known. Possibly it dissolves the silica in order to form a shell such as those of the microscopic diatoms that make up the fine siliceous deposits found in Germany and other countries. Glass is not the only hard substance that may succumb to such attacks, for a species of bacteria is known to disintegrate the hardest cements, and has thus wrought havoc in water reservoirs.

BOILER HORSE POWER FOR HEATING AND POWER.

CHAS. L. HUBBARD.

The standard for one "boiler horse power" is the evaporation of 30 pounds of water from a temperature of 100 degrees into steam at 70 pounds gage pressure. This is equivalent to the evaporation of 34.5 pounds from a temperature of 212 degrees into steam at atmospheric pressure, and requires $34.5 \times 966 = 33{,}327$ heat units, which for all practical purposes we may take as 30,000.

It has been found by experience that in plain tubular boilers, one square foot of heating surface will evaporate about 2.3 pounds of water "from and at 212 degrees," which corresponds to 15 square feet of heating surface per H. P. ($34.5 \div 2.3 = 15$). In well proportioned boilers, with careful firing, this can be somewhat reduced and some engineers give as low a figure as 11.5 square feet per H. P. All computations and tables given in this article will be based on 15 square feet per H. P., which experience has found to be safe and to result in durable construction. In computing the heating surface of tubular boilers it is customary to take one-half the area of the shell, two-thirds the rear head less the tube area, and the interior surface of all the tubes.

The H. P. required for heating a building may be computed in different ways, according to the data at hand. It may be based on the radiating surface to be placed in the building, or upon the heat loss through walls and windows. If ventilation is to be provided for a part or the whole of the building special allowance must be made for this also. Let us first take up the case where the amount and kind of radiation to be supplied by the boiler is known. One square foot of direct radiation, provided with low pressure steam (2 to 5 pounds), will give off from 200 to 300 heat units per hour. We may take for the average cast-iron radiator of medium height and thickness, an efficiency of 250 heat units; for a pipe coil, 300; for indirect pin radiators or other cast-iron indirect radiators of similar form, 600; although indirect radiation is not so efficient in heating the room itself, and for steam blast, 1,500. From this we have:

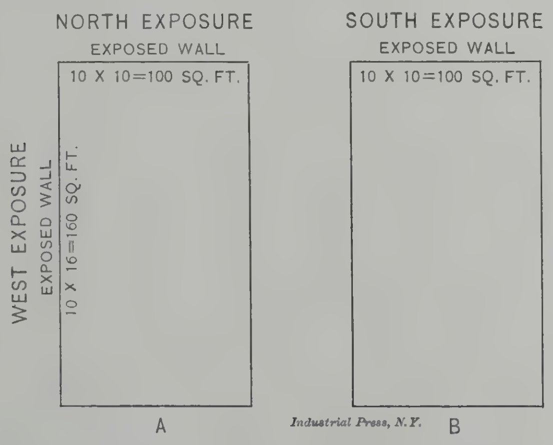
$$\frac{30{,}000}{250} = 120 \text{ sq. ft. direct radiator per H. P.}$$

$$\frac{30{,}000}{300} = 100 \text{ sq. ft. direct pipe coil per H. P.}$$

$$\frac{30{,}000}{600} = 50 \text{ sq. ft. indirect radiator per H. P.}$$

$$\frac{30{,}000}{1{,}500} = 20 \text{ sq. ft. steam blast per H. P.}$$

When the radiating surface of a building is not known we must either first compute it by one of the various methods in use or calculate the horse power directly from the heat loss through the walls and windows of the building.



Industrial Press, N.Y.

Fig. 1.

It is common practice among steamfitters and others to base the radiating surface required for any given room upon its cubic contents. While this is a convenient way of making approximations or of checking up results obtained in other ways, it is not accurate enough for computing the sizes of radiators for separate rooms unless the results are corrected for different conditions by a person of experience. This is made evident by an illustration. Take the case of two rooms having the same cubic contents and located as shown in Fig 1. *A* has an outside wall exposure of $100+160=260$ square feet toward the north and west, while *B* has only 100 square feet of exposure toward the south. While a person of any experience would make a difference in the size of radiators of the two rooms, I have seen important pieces of work in which the radiating surfaces had been computed from the cubic contents of the room, regardless of the wall exposure.

When we come to deal with whole buildings instead of separate rooms the method becomes more rational and may be used with a fair degree of accuracy.

The following table has been made up from the averages of several different rules in common use, and gives the cubic feet of space that may be warmed by 1 square foot of different kinds of radiation for various types of buildings. From this table we may easily calculate another which will give the horse power per 1,000 cubic feet of space for the different types of buildings named above.

TABLE I.

KIND OF BUILDING.	Direct Cast Iron Radiators.	Direct Pipe Coils.	Indirect Cast Iron Radiators.
Dwellings	50	60	35
Stores, Wholesale	125	150	90
" Retail	100	120	70
Banks and Offices	70	85	50
Dry Goods Stores	80	95	60
Large Hotels	100	120	70
Churches	150	180	105

TABLE II.

TYPE OF BUILDING.	Boiler H. P required for each 1000 Cubic Feet of Space for Direct Radiation.	Boiler H. P. required for each 1000 Cubic Feet of Space for Indirect Radiation.
Dwellings	.167	.286
Stores, Wholesale	.066	.111
" Retail	.083	.143
Banks and Offices	.119	.200
Dry Goods Stores	.104	.166
Large Hotels	.083	.143
Churches	.055	.066

For example.—Take the case of a large hotel to be heated with direct cast-iron radiators. From the above table we find that 1 square foot of radiation will heat 100 cubic feet of space; or $1{,}000 \div 100 = 10$ square feet will be required to heat 1,000 cubic feet of space. We have already found that 1 boiler H. P. will supply 120 square feet of direct cast-iron radiators. Therefore $10 \div 120 = .083$ H. P. is required for each 1,000 cubic feet of space to be warmed. In the same manner this may be found for different types of buildings for both direct and indirect radiators. We will now take up a more accurate method, in which the exposed wall and window surfaces, the construction and location of the building are taken into consideration, as well as the cubic contents. The heat loss from a building takes place in two ways: First by conduction through the walls and windows, and second by leakage around doors and windows and even through the walls themselves.

TABLE III.

MATERIAL.	Heat Units Loss per Square Foot per Hour with Outside Temp. at 0.	Heat Units Loss per Square Foot per Hour with Outside Temp. at 20° below 0
12″ Brick Wall	17	22
16″ " "	14	18
20″ " "	13	16
24″ " "	11	14
28″ " "	10	13
Wooden Construction	14	18
Single Windows	70	90

The average loss by conduction in heat units per square foot of exposed surface per hour for different kinds of walls and for windows are given in Table III, P. 305. Column 2 gives values when the outside temperature is at 0 and column 3 when it is 20 degrees below zero. It is assumed in each case that the inside temperature is to be maintained at 70 degrees. The actual heat loss is obtained by multiplying the square feet of exposed wall and window surface by the corresponding factor for the case in hand.

To the heat loss found by the above table must be added that due to leakage. It is customary to consider this equal to one change of the entire contents of the building every hour under ordinary conditions. The amount of heat lost in this way may be computed as follows: One heat unit will raise the temperature of 1 cubic foot of air 55 degrees at average temperatures and pressures, or it will raise 55 cubic feet 1 degree. Therefore the heat units required to raise any given quantity of air through any number of degrees in temperature may be found by multiplying the cubic feet of air by the number of degrees it is to be raised, and divide the result by 55. If the entire amount of air in a building is lost by leakage every hour, it must be replaced by unheated air from out-of-doors; and the heat lost by leakage will be that required to raise the incoming air to the inside temperature of the building. In zero weather this will be

$$\frac{\text{Cubic contents of building} \times 70}{55}$$

This is simplified by computing the loss for 1 cubic foot of space and multiplying the cubic contents of the building by the factor thus found.

For zero weather we have,

$$\frac{1 \times 70}{55} = 1.3$$

and for 20 below zero,

$$\frac{1 \times 90}{55} = 1.64$$

For example.—What horse power of boilers will be required in zero weather to heat a building 40×80 feet, having 3 stories, each 10 feet high? The walls are of brick 16 inches in thickness and the window area equals one-fifth the total exposed wall area.

Total exposed wall and window area $= (40+40+80+80) \times (3 \times 10) = 7{,}200$.

Window area $= 7{,}200 \div 5 = 1{,}440$.

Net wall area $= 7{,}200 - 1{,}440 = 5{,}760$.

Cubic contents of building $= 40 \times 80 \times 30 = 96{,}000$.

The heat loss per hour will be,

$$\begin{aligned} 1{,}440 \times 70 &= 100{,}800 \\ 5{,}760 \times 14 &= 80{,}640 \\ 96{,}000 \times 1.3 &= 124{,}800 \\ \hline & 306{,}240 \text{ heat units.} \end{aligned}$$

and

$$\frac{306{,}240}{30{,}000} = 10.2 \text{ H. P.}$$

This should be increased 10 per cent for the leakage through roof if there is an attic space, giving,

$10.2 \times 1.1 = 11.2$ H. P.

If there is no attic space, the roof should be counted the same as wooden construction, which in the above case would give $(40 \times 80) \times 14 = 44{,}800$, and the total heat loss would be, $306{,}240 + 44{,}800 = 351{,}040$, which divided by 30,000 gives 11.7 H. P. This is based on the assumption that the building is sheltered by other buildings. If it stands by itself in an exposed location, the boiler power should be increased about 20 per cent. over that given in the above case,

$11.7 \times 1.2 = 14$ H. P.

Small heating boilers have been found to be less efficient than those of larger size, depending partly upon their construction, but more especially upon the unskilled firemen usually employed in caring for them. The following factors, computed from data given by Prof. Carpenter in "Heating and Ventilation of Buildings," may be used for increasing the power of the smaller sizes, when calculated by the rules already given:

Boilers of 5 H. P., multiply by 1.4.
Boilers of 10 H. P., multiply by 1.23.
Boilers of 15 H. P., multiply by 1.14.
Boilers of 20 H. P., multiply by 1.07.

In the foregoing discussion the usual average conditions of chimney draft, fuel and care have been assumed. These vary so widely in different cases that no *exact* rule can be given to cover all conditions. The actual power of boilers depends so largely upon the draft, care of heating surface, and management of fires, that they may be made to develop under favorable circumstances a capacity at least 30 per cent. above their ratings. This, however, is not usually taken into account when computing the required size of a boiler for any special purpose, but is held as a reserve power for emergencies. Cast-iron sectional boilers are used almost exclusively for warming dwelling houses, and also used to a considerable extent in churches, halls, etc. When a boiler of this type is required its power is usually based upon the grate surface and the probable rate of combustion. The ratio of heating to grate surface varies from 15 to 25 in the best makes. For these we may assume a combustion of 5 pounds of coal per square foot of grate and an efficiency of 60 per cent., which corresponds to about 8,000 heat units per pound of coal available for useful work.

In computing the size of boiler for any given case it is only necessary to find, by some of the methods given, the total number of heat units to be supplied per hour, and divide this by $(8{,}000 \times 5)$ which will give the required grate area in square feet. The most efficient rate of combustion will depend somewhat upon the ratio between the grate and heating surfaces. It has been found by experiment that about ¼ pound of coal per hour for each square foot of heating surface seems to give the best results, so by ascertaining the ratio of heating surface to grate surface for any given make of boiler, we may easily compute the most efficient rate of combustion and from it determine the necessary grate area.

For example.—The heat loss from a building is 480,000 heat units per hour? We wish to use a heater in which the ratio of heating surface to grate area is 24. What will be the most efficient rate of combustion and the required grate area? $480{,}000 \div 8{,}000 = 60$ pounds of coal to be burned per hour; and $24 \div 4 = 6$, which is the best rate of combustion to employ.

TABLE IV.—NON-CONDENSING.

Boiler Pressure.	Ratio of Expansion.					
	2	3	4	5	7	10
	Pounds of Steam per Hour.					
30	40	39	40	40	42	45
45	35	34	36	36	38	40
60	30	28	27	26	30	32
75	28	27	26	25	27	29
90	26	25	24	23	25	27
105	25	24	23	22	22	21
135	24	23	22	21	20	20

TABLE V.—CONDENSING.

Boiler Pressure.	Ratio of Expansion.					
	2	3	4	5	7	10
	Pounds of Steam per Hour.					
15	30	28	28	30	35	40
30	28	27	27	26	28	32
45	27	26	25	24	25	27
60	26	25	25	23	22	24
75	26	24	24	22	21	20
105	25	23	23	22	21	20
135	25	23	22	21	20	19

Therefore $60 \div 6 = 10$, the grate surface required.

If ventilation is to be provided in a building the boiler power for this must be computed and added to that already found for heating. This is computed in the same manner as that to cover the heat loss by leakage, and the formula is:

Cubic feet of air supplied per hour × degrees through which it is to be raised ÷ by 55 = heat units required, and this ÷ by 30,000 = boiler H. P. necessary to supply this heat.

Calculations for power boilers are based on the steam consumption of the type of engine to be used. Table IV above, from Prof. Thurston's "Manual of Steam Engine" gives the average quantity of steam required per H. P. per hour by different types of engines working under different rates of expansion. This applies to the best class of engines in common use when of moderate size and in good order. Small engines, having greater proportional losses in friction, leaks, radiation, etc., and receiving, generally, less care in construction and running than larger ones, require more steam per H. P. In such cases the figures in the tables should be increased at least 50 per cent.

Having ascertained from the tables the weight of steam required per hour for any given engine, and knowing the probable temperature of the feed water and boiler pressure to be carried, the weight of steam can be reduced to an equivalent evaporation "from and at 212 degrees;" and this result divided by 34.5 will give the boiler H. P. required. This should be increased somewhat for running feed pumps, etc., or for any other purpose for which steam is used.

* * *

THE NEW YORK AUTOMOBILE SHOW OF 1903.

As we go to press the annual automobile show is in progress at Madison Square Garden, and the number of exhibits is much larger than in previous years. The marked development in the character and quality of the products during the past year is very evident. The average product of the different builders is greatly improved in every respect, and what is most noticeable is the almost universal adoption of the French type of carriage, having the motor in a suitable casing in front of the chauffeur, the body and seats of the carriage being of the tonneau type. Even the manufacturers of steam cars are adopting this design, such concerns as the White Sewing Machine Co., makers of the White steam carriage, laying particular stress upon designs which resemble the French gasoline automobile, so far as outward appearance is concerned. Manufacturers of light runabouts are also shaping their vehicles after this style, and in the whole show there were but few carriages having the "horseless" look of the typical American carriage of a year or two ago, which retained the dashboard but not the thills.

The gasoline motor carriages were greatly in the majority, there being 63 makes of these exhibited, while only 13 makers of steam vehicles and eight of electric vehicles had exhibits. The touring car was in evidence everywhere, seating usually four people and costing in the neighborhood of $2,500.

As yet there is apparently no practical low-priced automobile on the market, the cheapest exhibited costing $550. There is a tendency to use air cooling for gasoline cylinders, either by arranging plans for creating a current of air, or by other means, thus avoiding the use of water entirely, making the motor adapted to the coldest weather. There was also nothing particularly new to be seen in the way of heavy motor trucks for commercial use, this part of the show being lamentably weak. It is apparent from this that one of the greatest uses of the automobile of the future—that of transporting heavy loads in our crowded city streets—is not receiving the attention it deserves. Apparently the sporting element in automobilism far outweighs the commercial element, so far as the use of it is concerned.

One of the most unpretentious exhibits—and to the writer the most interesting—was a complete set of cells of the new Edison storage battery. The set comprised 38 cells, weighing 600 pounds, and capable of driving a light runabout 100 miles. It is estimated that a lead battery weighing 100 pounds less, (or 500 pounds) would drive an automobile only 40 miles. The Edison battery is a work of art as regards construction, and shows that a great deal of study and experimental work has been done to develop it. To say that its construction is neat enough to create admiration on the part of any one versed in mechanical matters, is not an exaggeration. The plates in this battery are composed alternately of carbon and nickel, and of iron; one serving as negative and the other as positive pole. In charging the battery a deposit is formed on the half plate and this again is re-formed on the other half when the battery discharges, and there is absolutely no deterioration in the plates, so far as can be determined. The writer was shown one plate that had done use in a battery of a carriage which had traveled over 3,000 miles, and it showed no effect of its use. It was also said to weigh exactly the same as at the start. Another advantage claimed for the battery is that it can be charged rapidly, taking a few minutes only, without danger of injuring the battery, instead of requiring four or five hours, as with the lead battery.

The Edison storage battery will be on the market this spring, but the representative at the exhibit would give no estimates as to its probable selling price. If the battery will accomplish the results claimed for it, and it is placed on the market at a reasonable figure, the electrical automobile will certainly receive a great impetus and become the favorite vehicle with a large number of people.

* * *

EFFECT OF VIBRATION ON STEEL TUBING.

C. H. Benjamin.

It has frequently been claimed by the makers and by the users of bicycles that the steel tubing of the frames is unfavorably affected by vibration due to constant and long-continued use. The writer has heard bicycle men assert that frames taken from old machines are often brittle and easily broken on this account. This is evidently but another form of that persistent delusion concerning the so-called crystallization of iron and steel during use. Perhaps some may consider it a waste of powder to fire at ghosts, but if the ghosts can be thereby permanently laid, the expenditure will be justified.

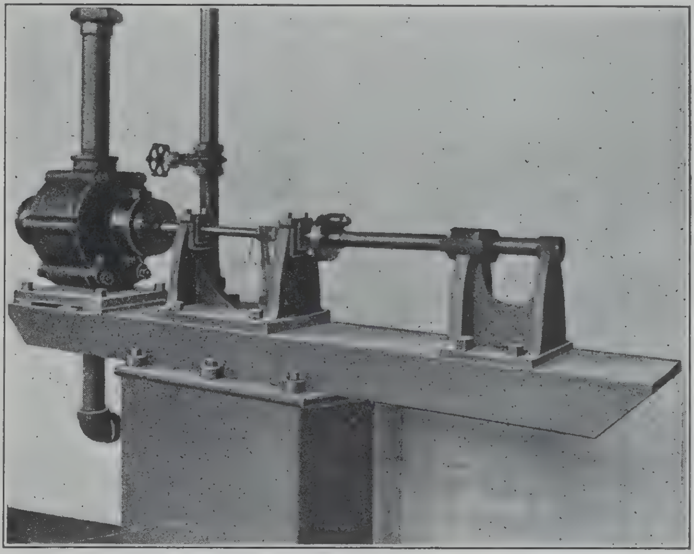


Fig. 1. Testing Apparatus Driven by Dow Turbine.

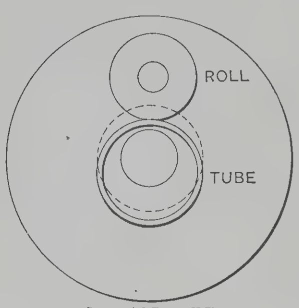
During the winter of 1898-99 a series of experiments on bicycle tubing was made under the direction of the writer. These tests were conducted at the laboratories of the Case School by Messrs. Austin and Brown, senior students. They merely served to confirm the opinions of good authorities on this subject, but the details may be of sufficient interest to warrant publication.

The cut, Fig. 1, shows the general arrangement of the apparatus, which resembles in construction a speed lathe. The tube to be experimented upon is clamped firmly in the tailstock of the machine and projects a greater or less distance to furnish a free length for vibration.

On the free end of the tube is a hardened steel sleeve, to protect it from injury. The revolving spindle carried by the headstock of the apparatus has a crank disk and pin fastened to its end and revolving with it. A hard bronze roll on the crankpin bears directly on the cylindrical sleeve beforementioned, rolling around it as the spindle turns. The axes of the revolving spindle and of the tube coincide but the surface of the roll is a distance from the axis less than the radius of the hardened sleeve. As the roll travels around the sleeve it accordingly springs the tube away from the center in every direction, giving to it what may be called a progressive vibration in all planes. Fig. 2 illustrates this springing of the tube.

The amplitude of the vibrations is easily changed by varying the size of roll. Several experiments showed the best results from a free length of nine inches and an amplitude of 5-64 inch. An attempt to use longer tubes resulted in the tube leaving the roll altogether on account of the centrifugal force at the high speed used. The deflection of $\frac{2.5}{64}$ in this length corresponded to a lateral pressure of 30 or 40 pounds, and a fiber stress of about 14,000 pounds—the stresses, of course, rapidly alternating between tension and compression.

The machine was driven by a Dow steam turbine, as may be seen in Fig. 1. The speed used was about 5,000 revolutions per minute and a run of between three and four hours was sufficient to give a million complete vibrations to the tube.



Industrial Press, N.Y.

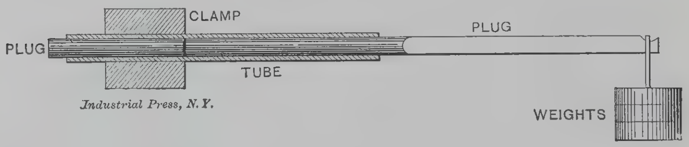
Fig. 2.

A four-break commutator was attached to the spindle and this put in circuit with a battery and a telephone receiver.

By comparing the musical tone produced in the receiver with a pitch pipe and tuning fork the speed could be readily determined.

Pieces cut from the same tube, one of which had been subjected to vibration and one not, were tried in the testing machine and the tensile strength and modulus of rupture determined.

The tensile tests were made in the usual manner, plugs being fitted inside the ends of the specimens, to prevent the jaws of the machine from crushing them. The cross-breaking tests were made by inserting plugs at each end which met near the middle of the specimen. The tube around the shorter plug being clamped in a cylindrical holder, weights were attached to the end of the longer plug at a point about 30 inches from the clamp—until the specimen broke in two at the joint.



Industrial Press, N.Y.

Fig. 3.

This method avoids any danger of collapsing or crushing the tube and gives a clean break at right angles to the axis, as shown in Fig. 3.

TABLE I.

No.	Kind of Tube.	Number of Vibrations.	Bending Moment, lbs. inches.	Fiber Stress due to Deflection.	Ultimate Load in Tension.
2	Pope, .50 Carbon	500,000	....	......	9,160
3	Pope, .50 Carbon	None	....	......	9,140
5	Brazed Tube	1,000,000	342	14,700	8,080
6	“ “	None	....	......	8,630
11	Pope, .50 Carbon	1,000,000	....	......	10,530
12	Pope, .50 Carbon	None	....	......	10,640
20	Shelby	1,000,000	324	14,000	6,800
21	“	None	....	......	6,890
30	Pope, Nickel	1,000,000	288	12.300	7,200
31	“ “	None	....	......	7,450

Three different makes of tubes were tested but no attempt was made to compare the three kinds, the object being solely to determine the effect of vibration. Table 1 shows the results of the tension experiments and Table II. those of the cross-breaking.

Tubes Nos. 5 and 6 in Table I. had been heated and dipped into a brazing bath, as bicycle joints are sometimes treated.

A comparison of the figures for the two tubes in each pair, as bracketed in the first column, showns no material differences between the vibrated and un-vibrated specimen, as regards either tensile or cross-breaking strength. In other words, one million repetitions of a tensile stress of 12,000 or 14,000 pounds, alternating with compressive stresses of the same amount, have no perceptible effect on the strength or character of steel tubing. The appearance of the metal at fracture was the same, no sign of molecular change being apparent.

TABLE II.

No.	Kind of Tube.	Number of Vibrations.	Breaking Load at 29½ inches.	Modulus of Rupture.
1	Pope, .50 Carbon	1,000,000	90	114,000
4	Pope, .50 Carbon	None	95	120,500
10	Pope, .50 Carbon	1,000,000	101	128,000
13	Pope, .50 Carbon	None	101	128,000

Some of the characteristics of the different varieties are, however, well brought out. Nos. 2, 3, 11 and 12 were of the same kind and make, but the last two were cut from a different tube and were about 15 per cent. stronger. Nos. 5 and 6 were from the same tube as 2 and 3 but having been heated in a brazing bath were weakened thereby.

The chemical constitution of Nos. 20 and 21 was not known. The nickel steel, Nos. 30 and 31, was not so stiff as the other, and the same deflection caused less pressure and bending moment. This steel also shows less tensile strength than the .50 per cent. carbon.

* * *

THE DATA SHEET FOR THIS MONTH.

The tables presented on the data sheet accompanying this month's issue of MACHINERY were contributed by Mr. W. I. Mann, Pittsburg, Pa. They comprise a list of circumferences and diameters from 1 to 300 and a table of the lengths of chords for spacing a circle whose diameter is unity. The table of circumferences and diameters is deserving of particular notice in that it is arranged in the reverse order from that usually found in tables of this kind. The tables which are found in all of the standard hand-books give the diameters in whole numbers, halves, quarters and sometimes eighths and the corresponding circumferences in decimals to three or five places, as the case may be. This table reverses this arrangement and gives the circumferences in whole numbers and the diameters in decimals to four places.

It often happens that the most convenient way to make a measurement is circumferentially and to obtain the diameter the result is divided by 3.1416 or, what is more convenient, multiplied by .3183. The result would, of course, be found directly from this table. Another application of the table is found in laying out gearing to circular pitch. The circumferences, in this case, are usually in whole numbers, being the product of an even pitch by the number of teeth. For example: Required the pitch diameter of a gear having 215 teeth, 2-inch pitch. In the table, opposite 215 we find 68.4366 which would be the diameter in inches if the gear was 1 inch pitch, therefore for 2-inch pitch the diameter will be 2 × 68.4366 = 136.8732 inches.

The table of chords will be found useful for spacing drilled holes on a circle of given diameter, laying out gear teeth, or determining the length of the side of a regular polygon of any number of sides. In making a pattern, suppose it is desired to space off 21 teeth on a pitch circle 18¼ inches in diameter. In the table, opposite 21 we find .149. Then 18.25 × .149 = 2.719, the distance to be taken on the dividers. If it was required to lay off 40 holes in a cylinder head or pipe flange on a drill circle 46½ inches in diameter, opposite 40 in the table we find .0785 and 46.5 × .0785 = 3.65 the straight distance from center to center of the holes.

* * *

The potential power of Niagara River at the Falls, is estimated by various authorities to be from 6,000,000 to 7,000,000 horse power.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The *Sibley Journal* states that Prof. R. A. Allen, of Cornell University, has conducted tests on liquid air engines from which he finds that the best efficiency that can be obtained is about 8 per cent. of the energy expended. The expenditure of one horse power continuously for one hour results in the production of enough liquid air which, if utilized in its turn as a source of power in a perfect machine, would produce one horse power for one minute. The most efficient method of obtaining liquid air yet discovered would increase this last to a period of time of about five minutes.

The mechanical draft plant of the Union Electric Light & Power Co. to be used for lighting the World's Fair grounds, at St. Louis, will be equipped with both forced and induced draft apparatus. Generally either the forced or the induced draft is used, but in this case both will be installed. There will be twenty-six 700 H. P. boilers, equipped with automatic stokers. Four fans of the full housing type, size 160 inches, will be used for the forced draft, and will be driven by 10 x 10 vertical engines, directly attached. Two fans, also of the full housing type, 230 inches in size, will be used for the induced draft. These fans will be driven by 9 x 10 double-cylinder, double-acting upright engines, this type being selected to secure the maximum power in limited space. The apparatus will be installed by the Buffalo Forge Co., Buffalo, N. Y.

THE NATURE OF WORM THREAD CONTACT.

In an article published in the *American Machinist* on the nature of worm thread contact, Oscar J. Beale, of the Brown & Sharpe Manufacturing Co., concludes from the result of a practical experiment that the contact between the teeth of a worm wheel and a worm thread, is a line ratner than a point, as Mr. Grant seems to believe, according to the statements made in his well-known book on gears. Mr. Beale made a model worm and worm wheel, the worm being about 1½-inch pitch and the worm wheel about 3 inches diameter at the roots of the teeth, of which there were only seven. This model was carefully fitted and the ends of the 7-tooth worm wheel were cut off to a length of about 4 inches, so that the nature of the contact could be observed when the two were in contact. From visual evidence, and tests made by bluing one member and pressing the two members together, also by rotating them in mesh, while one tooth was blued, a number of witnesses came to the conclusion that, as already stated, contact between a worm thread and a tooth of a worm wheel is along a line. The models used for this experiment may be seen at the works of the Brown & Sharpe Manufacturing Co.

NEW USE FOR CARBORUNDUM.

The *Electrical Review* (London) says that a new and valuable use has been discovered for carborundum, which is manufactured at Niagara Falls by the Acheson process, and that is, covering firebrick with a highly refractory coating. Since carborundum can only be melted at extremely high temperatures, the electric furnace being required for the purpose, it follows that the temperatures ordinarily generated for smelting of ores and metals are much below its fusing point. Finely powdered carborundum is made up into a paste with water-glass, i.e, sodium silicate, or some similar binding substance; and the paste is applied by means of a brush, or otherwise, to the bricks which are intended to be used for building a furnace, or those bricks are actually immersed in the viscid liquid for a certain time. If the furnace has already been built, the paste can be painted on to the exposed surfaces, giving one or more coats as may be desired. It is stated that a layer 1-12-inch thick will protect the bricks from the attack of the highest temperature which is ever produced by combustion methods in ordinary work; examination of the bricks in such a furnace (after it had been pulled down) having shown that they had not suffered in the least. The skin of carborundum does not chip off, and is hard enough to resist mechanical injury.

ECONOMY OF REHEATING AIR.

Results of tests by students at Cornell University upon the economy derived by re-heating air were recently published in the *Engineering and Mining Journal.* Gas was used as fuel for re-heating and was also metered, thus making very accurate testing possible. The motor was a two horse power vertical engine with a shaft governor, and was provided with a Prony brake and an indicator. The series of tests was made with several one-hour runs, gage pressure varying from 57 to 82 pounds, and pressure of air raised by re-heating from 90 degrees to 320 degrees, the results being carefully recorded and tabulated. The following summary of the tests is from the *Engineering News.* For general purposes we need only give the following summary of results: (1) The net gain in economy was greatest for the lower gage pressure of 57 pounds; (2) The curve of efficiency indicates that there would be no further gain by heating the air above 450 degrees F., and with the engine used 400 degrees F. was the maximum temperature consistent with smooth running, on account of the ill effects of a higher temperature upon packing and lubricant; (3) Reheating the air relieves the engine from difficulties due to freezing of the moisture in the exhaust passages, with resulting choking; (4) The economic advantages of reheating were conclusively proved. A compressor able to supply 100 horse power of cold air to the motor, could supply 178 horse power by the use of reheaters.

USES FOR ALUMINUM.

From time to time we have noted certain interesting discoveries and processes connected with the working of aluminum; also new uses. A stock item has been new solders which were supposed to be useful for soldering this difficult metal. In general aluminum solders do not appear to be unqualified successes. This time we note a process for welding aluminum, one for hardening it, and the use of aluminum as a whetstone for sharpening edged tools. A New York woman has been granted a patent for the aluminum welding process, which appears to be exceedingly simple. The parts to be welded must be scrupulously clean and raised to a temperature of about 1,100 degrees F., at which temperature aluminum softens. Pressure is then applied until the two parts are united, the temperature being maintained constant during the process. The hardening process consists of alloying aluminum with from 2 to 10 per cent, of magnesium and then passing it several times between rollers while at a temperature of from 750 to 930 degrees F. The result is a metal that cuts and files well and still has all the ductility and malleability of pure aluminum, the hardening process merely improving its working properties. As to the use of aluminum for sharpening tools this is the alleged discovery of a German who avers that an aluminum stone is superior to the ordinary oil stone in every particular. A demonstration of this claim should not be difficult.

THE HISTORY OF THE SLIDE REST.

The slide rest which is such an important and indispensabl feature of the lathe, planer, and in fact of all machine tools, was the invention of Henry Maudslay, but the logical development of the idea into the slide lathe for screw cutting and long turning, we are told, was the work of a Manchester inventor. W. H. Bailey, in an interesting historical article, "The Mechanical Inventors of Manchester," in the December issue of *Cassier's Magazine,* says that the invention of the slide lathe is due to Richard Roberts and that the first slide lathe is working in the shops of Beyer, Peacock & Co., at Gorton, England. The carriage of this lathe is on the front of the bed instead of being on top as in general practice now. Roberts brought out this improvement about 1816. The front slide lathe is again coming into use to some extent in England.

Roberts also invented an iron planer, an automatic emery grinding machine, a slotting machine, an automatc drilling machine and a punching machine that would punch holes in plates automatically to any pattern desired. The pattern was controlled by a card which was introduced into the machine and used in much the same manner as the cards in the jacquard loom. Machines built on this plan were used for punching the plates of a number of large tubular bridges, including the Brittania, Menai, Conway, St. Lawrence, etc. The writer claims that Roberts was the inventor of the first iron planer of the type now used, but proof of this is quite impossible since the early contemporary inventors kept their inventions secret and enjoyed the advantages accruing from the use of their machines, making exact dates unknown. It is quite certain, however, that a number of planing machines were in use at about the time that Roberts invented his.

A NOVEL STEAM TURBINE PLANT.

A unique steam turbine installation is to be made by the Westinghouse Machine Co., Pittsburg, Pa., at the Cumberland Mills, Portland, Me. These mills are electrically driven, most of the current being supplied by several water power plants and the balance by a steam plant. In anticipation of trouble in the water supply, through floods, anchoring or drouth, it was decided to add another steam plant, and after considering the subject carefully a steam turbine was ordered, and it will be used solely for the purpose of a relay or reserve power. So far as we know this is the first steam turbine installation for relay purposes.

The turbine is of the Westinghouse parallel flow type, of 540 horse power capacity, and will operate under a steam pressure of 165 pounds, receiving its supply from a boiler plant located some distance (350 feet) from the unit. The steam before entering the turbine will be superheated approximately 100 degrees F. by means of an independent superheater located just outside of the building and fired by waste hydrogen gas rising from electrolytic baths used in the process of manufacturing at the plant. This gas has heretofore been a waste by-product and is here utilized for the purpose of re-evaporating condensation in the long steam line and superheating the steam to a point where the increased economy of the turbine at superheat temperature is available. The turbine will operate at a high vacuum—28 inches—which is supplied by a condensing system employing a surface condenser with gravity circulation.

The generator is mounted upon the same bedplate as the turbine and is direct driven from the turbine shaft through a flexible mechanical coupling. The space occupied by the unit is 70 square feet per horse power. The steam economy will approximate 13.5 per E. H. P. at 100 degrees superheat, which is equivalent to less than 11.0 pounds per I. H. P., as rated in reciprocating engine practice.

REMARKABLE PROPERTIES OF NICKEL STEEL.

In the November, 1901, issue of MACHINERY, mention was made of a nickel-steel alloy containing about 36 per cent. of nickel, which has most remarkable properties. The coefficient of expansion is only about one-thirteenth that of wrought iron, or .0000005 for one degree F. It is also said to resist oxidation to such an extent that polished pieces may be exposed for weeks to the air with scarcely appreciable damage, where ordinary iron and steel would quickly coat with rust. Naturally such a metal would be of great value in the arts for the construction of instruments of measurement and for the pendulums of clocks, which latter use was mentioned. This alloy was discovered in France, but the published accounts of the properties of the alloy were received with doubt in the United States, some scientists, in fact, denying that such nickel alloy properties were possible. Now, the *American Machinist* of January 8 publishes a letter from Ch. E. Guillaume, Associate Editor of the International Bureau of Weights and Measures, which affirms the statements made regarding the low coefficient of expansion, and adds some interesting facts. He says that all clocks of precision now made in Germany, are fitted with nickel-steel pendulum rods in place of the mercury compensation rod formerly used. The alloy is also being used in France and Switzerland. It is being employed for geodetic instruments and theodolites, having been adopted for this purpose by the U. S. Coast and Geodetic Survey. M. Guillaume furthermore says that it is possible by the addition of iron or nickel to the least expansive nickel alloy, to make an alloy having almost any desired coefficient of expansion. In this way "platinite" is made which has the same expansion coefficient as platinum, and also, of course, as glass. It is well known that every incandescent electric light globe made in the customary way, requires two tiny pieces of platinum sealed in the glass to form the connections with the wires and carbon filament, platinum having to be used to pass through the glass because it was the only metal known that had the same rate of expansion and contraction. The consequence is that platinum has risen in price higher than gold because of the great demand for it in the electric lamp manufacture. "Platinite" is now being quite extensively used in European factories in place of platinum.

ABOUT SUPERHEATED STEAM.

In a paper on superheated steam, read before the December meeting of the Engine Builders' Association, Mr. E. H. Foster stated that there have probably been as many as 7,000 superheaters installed in European power plants. Superheaters are installed in a variety of ways. The steam from the boiler drum may be passed through pipes so placed in the boiler setting proper as to intercept the hot gases and raise the temperature of the steam beyond that due to its pressure, or the superheater may be in a separate setting supplied with its own furnace or so arranged that the boiler gases will be deflected through it. The coils are made of seamless drawn steel or cast iron of a composition designed to stand high temperatures. On account of the diminished density of superheated steam the sizes of steam pipes and ports may be reduced about 20 per cent. from what would be necessary for saturated steam for the same power. The velocity of superheated steam in pipes should be near 6,000 feet per minute to secure a minimum drop in pressure and at the same time a minimum loss of temperature. Steam jackets are unnecessary as a feature of economy in the operation, but the author thinks that they are possibly advisable on high-pressure cylinders to facilitate warming up and starting large engines. The efficiency of superheated steam engines has been demonstrated in this country by the acceptance tests of some vertical compound engines for electric lighting service in Boston. These engines, which were of 1,200 and 2,400 horse power, showed a feed water consumption of 12.54, 12.51, and 12 pounds on full load, three-quarter load, and one-half load, respectively. The superheat was 80 degrees, 64 degrees and 48 degrees, respectively, at the high pressure admission, and 60 degrees, 67 degrees and 84 degrees, respectively, at the low-pressure admission. These engines have reheaters and steam jackets on both cylinders. Better economy would have resulted if the jackets had been left off the low-pressure cylinders. Mr. Foster says that the question of lubricating the cylinders with superheated steam is not serious, and that many have borrowed a lot of unnecessary trouble anticipating conditions that are not met with in practice. It should be borne in mind that the temperature inside the cylinder is never very high, even though the degree of superheat is considerable. If the cylinder is lubricated directly without mixing the oil with steam at the entrance point, there cannot possibly be any trouble. With good grades of mineral oil it is possible to successfully lubricate the cylinders in the ordinary way practiced with saturated steam. Poppet valves, of course, are used on the high-pressure cylinder.

A POSSIBLE SLOW-SPEED GENERATOR AND MOTOR.

In his presidential address read before the Institution of Electrical Engineers, James Swinburne referred to an interesting principle in generator and motor construction which, if certain defects could be overcome, would make possible and feasible the construction of slow peripheral speed generators and motors giving a high electromotive pressure, or in other words, a high voltage. A slow speed motor is a highly desirable feature of successful electric railway operation, and such a motor ought also to find extensive application in driving shop tools. The cut shows the principle diagrammatically. The field has a number of N and S poles in succession, as usual in an alternator, and is laminated. The armature is drum-wound as if for a two-pole field, and it has teeth which come opposite N poles on one side of the machine and S on the other. A very small movement of the armature causes the positions of correspondence to change rapidly, so that the magnetic field rotates rapidly. Thus, if there are 11 armature teeth and the speed is, say, 200 rotations per minute, the field rotates at 2,000, giving the corresponding pressure.

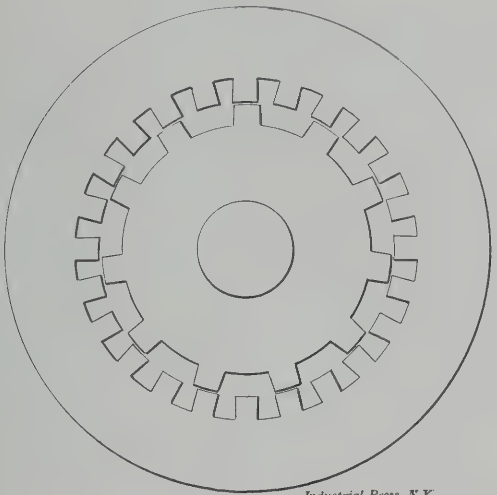

Industrial Press, N.Y.

Fig. 1. Diagram Illustrating Principle of Slow-speed Generator and Motor.

If the field rotates with the armature the effective speed is 1,800; if the other way, 2,200. The difficulty in such a machine will arise from magnetic leakage. The armature reaction is also considerable. But reversing devices analogous to those proposed and used by Edison, Houston, Sayers, Atkinson, and others are available, and the machine may be made so that the armature largely excites the field in the case of a generator, and wholly excites it in the case of a motor. It is a question whether such a device as this may give us a light, compact motor.

NOISY GEAR WHEELS.

Cassier's Magazine. January, 1903. p. 459.

The difference between noisy gears and quiet gears, says Oscar J. Beale, is often so slight that an expert cannot decide, by mere inspection, to which class a given pair of gears belongs. Both kinds are not infrequently produced in the same lot, apparently under the same conditions. This is disquieting, and may lead to misunderstanding. The inspector has heard so many explanations as to how the bad work came about that he has become skeptical, and when he is told that the noisy gears were turned, cut, and fitted to place exactly like the quiet gears, his belief in narrative statements receives another shock.

A pair of gears about an inch in diameter, at 10,000 to 15,000 revolutions per minute, will sometimes set up a distressing noise, approaching the shriek of a small steam whistle, which may come from motion of the air and not from faults of construction. And so a constructor of gears has a peculiar anxiety—he is not at all concerned as to the geometrical movements of his gearing so long as it will keep quiet. He has various devices, other than the correct shaping of the teeth, with which he hopes to avoid disagreeable sounds; if he has light power to transmit, he may choose a fine pitch for the teeth; he may make his gears of brass, sometimes of rawhide, and again of compressed paper.

One of the details of construction that may cause noise is that the depth of the tooth spaces is not right. In this respect gears are oftener cut too deep than not deep enough, and it is worse to have the driver too deep than the driven gear. Another cause of noise may be that the cutting is not central. This may be shown by gears being noisy in one direction and quiet when running in the other direction. Again, the center distance may not be right; if meshing too deep, the outer corners of the teeth of one gear may strike hard against the roots of the teeth of the other gear. Still another reason for noise may be found in the fact that the frame carrying the gear shafts may be of such form and size as to give off sound vibrations.

THE VARIABLE SPEED ELEMENT IN THE OPERATION OF PUNCHING MACHINES.

Electrical World and Engineer. January 3, 1903. p. 25.

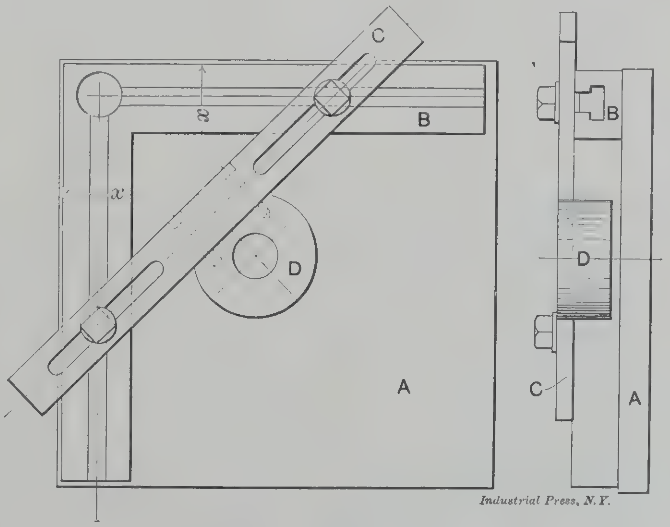
In discussing electrical power distribution in the shop, Kern Dodge says that in the case of a punching machine, it is commonly regarded as a constant-speed machine and intimates that it is usually installed with no provision for varying the speed, when as a matter of fact to get the maximum efficiency, it should be provided with means for varying the speed. To illustrate, if a punch is driven at a speed of, say, 35 strokes per minute, with light work, the operator may be able to punch a hole at every stroke, but if he gets work a little heavier, which will permit him to only punch 28 or 30 holes per minute, then he will have to miss every other stroke, which gives the machine a capacity of only 17½ holes per minute as against 28 or 30 if the motor could be slowed down to accommodate the work.

In selecting a motor for a punching machine Mr. Dodge says that it is perfectly safe to overload a motor 30 to 40 per cent. at the instant of punching, as the actual time required for the punch to pierce the metal is but a fraction of the running time, but there are other elements that cannot be overlooked, and those are principally the size, weight and speed of the flywheel. In many cases a motor which is of ample power to operate a punch when it is once in motion, will not have sufficient starting torque to overcome the inertia of the flywheel. The best way to determine the power required is to temporarily belt a motor to the punch and take careful readings of the ammeter and voltmeter in the motor circuit. But the result will be misleading if the test motor employed is much larger than the actual motor required, since the larger motor will overcome the inertia of the flywheel quickly, which would not be the case with one much smaller.

JIG FOR LAYING OUT AND DRILLING HOLES IN JIGS.

Iron Age. January 1, 1903. p. 53.

A laying out and drilling jig for locating and drilling holes in jigs is described by "C. L. G.," who says that it is being successfully used with a large universal milling machine having a vertical spindle attachment, in one of the large shops in the East (Pratt & Whitney Co.). With this fixture holes may be located and drilled in plain plate jigs with rapidity and within close limits.



Industrial Press, N.Y.

Fig. 2. A Laying out Jig.

A is a flat plate which must be planed true; *B* is a square provided with a T-slot groove; *C* is a bar for holding the ground bushing *D*. The outer diameter of the bushing *D* is ground to exactly 2 inches diameter. The dimension *x* on the square *B* is exactly 1 inch. Work in which holes are to be located is fastened to the plate *A*, and the bushing *D* is brought directly in line with the various holes to be drilled by means of micrometer measurements between the edge of the bushing *D* and the square *B*, these measurements being taken at right angles to each other, either from the inner side of the square and bushing or the outer edges, according to which is most convenient. The workman takes into consideration in making measurements one-half diameter of the bushing *D* and the width of the square *x*. A standard set of bushings can be made to suit various diameters to be drilled. It is evident that this method of locating holes does not possess the refinements of means employed on some elaborate jigs, but has been found sufficiently accurate for most machine shop jigs.

THE LOCOMOTIVE SPARK ARRESTER.

Railway and Locomotive Engineering. January, 1903. p. 16.

In the course of an article on the development of the locomotive spark arrester, J. Snowden Bell says that so far as record evidence is available the "smokebox" spark arrester, that is, the type in which the netting is located in the smokebox as in the generally-followed present practice, was first proposed by J. McIlvaine, of Philadelphia, in 1833. An article contributed by McIlvaine to the Journal of the Franklin Institute, Vol. XII, N. S., 1833, illustrates the idea clearly. The netting was set in an inclined position, the top being next to the tube sheet and the exhaust pipe passing up through the middle. This design was never patented. To Isaac Dripps is given credit for the inclined deflecting sheet now placed in front of the tube sheet so as to cause a more or less uniform distribution of the hot gases through all the tubes. This design, which was made in 1849 by Dripps, was referred to as an "arrangement of deflecting plates in front end of boilers for burning anthracite coal on the C. & A. R. R."

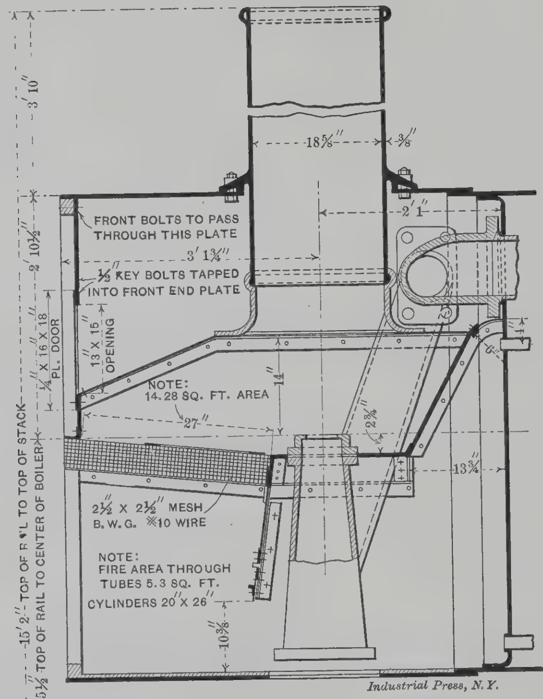

3′ 10″
18⅝″
⅜″
2′ 1″
FRONT BOLTS TO PASS THROUGH THIS PLATE
3′ 1¾″
½″ KEY BOLTS TAPPED INTO FRONT END PLATE
2′ 10½″
½″ X 16″ X 18″ PL. DOOR
13″ X 15″ OPENING
NOTE: 14.28 SQ. FT. AREA
14″
27″
2¾″
6″
1″
13¾″
2½″ X 2½″ MESH B. W. G. ※10 WIRE
NOTE: FIRE AREA THROUGH TUBES 5.3 SQ. FT.
CYLINDERS 20″ X 26″
10⅜″
15′ 2″ TOP OF R'L TO TOP OF STACK
8′ 5½″ TOP OF RAIL TO CENTER OF BOILER
Industrial Press, N. Y.

Fig. 3. Locomotive Front End for Intercolonial Engines.

The differences between the various forms of smokebox spark arresters now in use, are practically only those of detail, all embodying more or less perfected forms of the McIlvaine and Dripps designs. Mr. Bell refers to the design of front end used on 25 locomotives recently built for the Intercolonial Railway of Canada, which was designed by Mr. J. E. Muhlfeld, and says that the idea of increasing the effective length of stack by continuing it down into the smokebox, as shown in the cut, Fig. 3, was originated by Zerah Colburn in 1854, and was tried on the Columbia Railroad (now part of the Pennsylvania Railroad). The plan proposed by Colburn was to afford relief for roads having low bridges, tunnels, etc., and consisted of placing a sheet of iron across the smokebox just above the upper row of tubes and attaching the lower end of the stack to it. This not only increased the effective length of stack, but also reduced the volume of the front end, which Colburn deemed as being quite essential to good steaming qualities. Colburn's plan seems to have been abandoned, for reasons not given, which more than likely were no reasons at all more than the indifference of the mechanical department of that road.

We believe that Prof. Goss and his assistants at Purdue University have made experiments that confirm what has apparently been demonstrated by practice, i. e., that the effectiveness of a locomotive stack is increased by this expedient. Thus are old ideas revived and made useful.

PEAT FOR FUEL.

Outlook. January 17, 1903. p. 173.

In an article on the possibilities of peat, S. Power says that while New York is shivering in the grasp of a cold wave there are within two hours' distance sufficient peat deposits to keep its fires for two generations. New Jersey has peat deposits enough to last a century, Chicago is surrounded by it, the Wisconsin valleys are filled with it, Indiana might supply her neighboring states with peat fuel and never feel it, St. Paul has peat fuel beds to last her fires indefinitely. Some years ago a state geologist estimated the peat along the Hudson River, through Westchester and Rockland Counties, at over 2,000,000 cords. In fact peat is a fuel that is widely distributed over the earth's surface and has been used in a limited way for centuries, yet it is a fuel that is little known at the present time in the United States. One and four-fifths tons of air-dried peat are equal to one ton of good coal, and it burns smokelessly.

During the time of the Civil War coal became very scarce and high in some sections, and between 1860 and 1875 forty-six firms began to cut peat in New York, New England and Ohio. It was everywhere liked as a household fuel, and was an excellent steam fuel, but the supply seems to have been inadequate, or possibly peat fuel could not compete with coal, and it fell into disuse. Peat is ground and pressed into bricks on the Continent at a cost of sixty cents a ton. The writer also claims that it is being manufactured on this side of the water at a cost of $1.75 a ton. The manufactured peat is highly prized for household use in Holland on account of its cleanliness and because it takes up so little room.

SOLDERS FOR METAL.

L'Echo des Mines et de la Metallurgie. November 17, 1902.

The following solders are given as of practical value:

Soldering Tin to Cast Iron: Clean the iron with the greatest care and remove every trace of oxidation.

Coat with muriatic acid into which a little zinc shall have been previously placed.

Heat the iron to a point where the tin will melt when coming into contact with it.

Remove the piece and solder the tin in the usual way.

Solder for Copper: Take a solution of chloride of zinc and moisten the parts to be soldered, after seeing to it that they have been well cleaned, and then bring them together in the position which they are finally to occupy. Heat them with a blow pipe and allow the solution to evaporate. Then bring the tin into contact, which, as soon as it is hot enough, will melt and flow in between the surfaces. The latter will then be found to be perfectly soldered.

Solder for Lead: Scrape the surfaces to be soldered very carefully. Place between them a thin layer of lead amalgam and pass an ordinary soldering iron over the line of union. The heat will liberate the mercury of the amalgam and the lead thus set free will be found to be in a very finely divided condition and in a molten state that will serve to unite the two surfaces.

Cold Solder for Iron: Make a paste composed of

Sulphur	6 parts
White lead	6 parts
Borax	1 part

Dilute the whole with concentrated sulphuric acid.

Apply the paste and press the two parts tightly together and allow them to stand for six or seven days.—G. L. F.

INTERNAL GRINDING MACHINES.

Engineering (*London*), December 12, 1903. p. 767.

Joseph Horner describes a class of internal grinding machines made by some foreign machinery builders, which are adapted to grinding the holes in levers, forks, connecting rods, and other similar pieces of comparatively long dimensions which make it impossible and undesirable to swing them on the faceplate of an ordinary grinding machine of the lathe type. He first points out that for work that is to be swung around a stationary axis spindle a vertical spindle machine is preferable for internal work, for the reason that work of irregular shape runs in better balance and is easier chucked by the workman, who can also better see the progress of the work. But the class of machines he describes that are of particular interest, is that in which the spindle has a sun-and-planet motion, thus making possible the grinding of holes in pieces that cannot be swung.

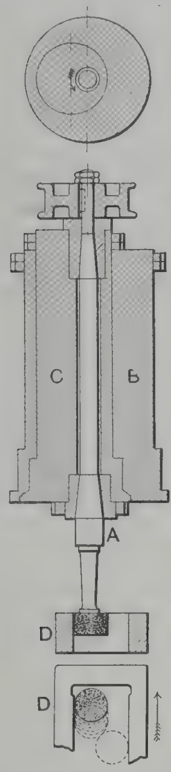


Fig. 4.

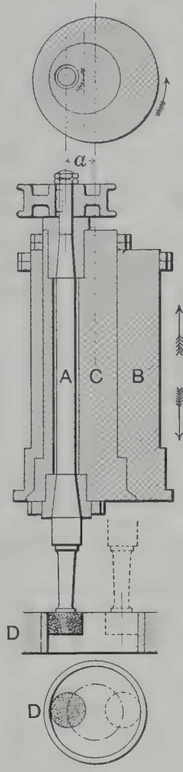
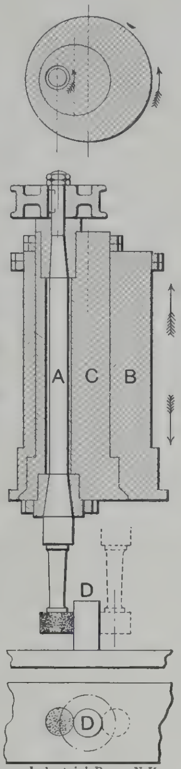


Fig. 5.



Industrial Press, N.Y.

Fig. 6.

The illustrations, Figs 4, 5 and 6, show sections through the spindle bearing of a grinder of this class made by Friederich Schmaltz, of Offenbach-on-Main. The three views show the grinding of an internal flat surface, the grinding of a hole and the grinding of a pin. In the first case the eccentric bushing *C* is locked in the second eccentric bushing *B* so that the spindle *A* is concentric with the exterior bearing and the grinding proceeds on the work *D* the same as with an ordinary vertical machine. In Fig. 5, the bushing *C* is set at its greatest eccentricity and carries the wheel around the interior as it is rapidly driven. In the same way the exterior of the pin is ground in Fig. 6. It will, of course, be understood that the degree of eccentricity is varied by shifting the relative positions of the eccentric bushings *B* and *C*. In the machine made by Le Progrès Industriel of Brussels, Belgium, this is accomplished by a tangent screw *a*, Fig. 7, meshing in a worm, the former being attached to the exterior bushing and the latter to the interior one. This spindle is an attachment that can be used with ordinary grinding machines, either of the horizontal or vertical type, or in a lathe. Means must be provided in all machines of this type for compensating the tension of the driving belt, which would otherwise be alternately tight and slack for opposite phases of the sun-and-planet motion. In the Schmaltz machine this is accomplished by running the driving belt over idler pulleys, which are counterbalanced so as to give and take, to accommodate the sun-and-planet motion. This is feasible since this motion is not rapid, being only 50 turns per minute for the Le Progrès Industriel machine while the spindle makes 4,200 rotations. The degree of eccentricity of the spindle of the latter machine can be varied from zero up to ⅝-inch radius. This range can be amplified by varying the sizes of the wheels on holes, but not on the external surfaces of pins for reasons that are quite obvious.

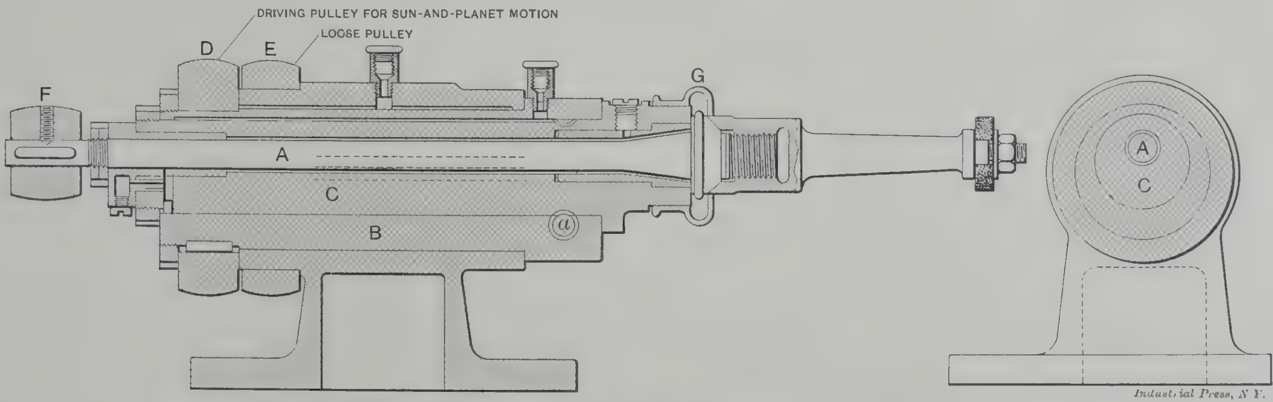


Fig. 7. Internal Grinding Head Construction employed by Le Progres Industriel

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THE HOPKINSON METHOD OF TESTING GENERATORS.

Science and Industry. January, 1903. p. 28.

The usual system of testing electric generators and motors in England, is that devised by the late Dr. John Hopkinson. W. H. Booth says that in practice it is only suitable for testing machines which are made in duplicate and are alike in all particulars. The prime advantage of the method is its economy; it is exceedingly convenient and accurate.

Two similar machines to be thus tested are preferably coupled upon the same spindle. They may also be connected by means of a belt, but this introduces the element of belt friction and renders it less easy to secure exact results. The two machines thus connected are worked respectively as a motor and as a generator, the motor machine driving the generator, which in turn supplies current to cause the motor to work. The idea is thus one of the kind that is such a favorite with the "perpetual motion" man. But there is a very important difference. In addition to the current from the generator machine, which goes to drive the motor, there is a further supply of current brought to the motor from an outside source. Let us suppose that the machines are each of 100 kilowatts capacity and that they each have an efficiency of 95 per cent. Then, if the generator is revolved by a power of 100 kilowatts, it will lose 5 kilowatts by bearing friction, windage, hysteresis, etc., and will deliver 95 kilowatts to turn the motor. The motor makes use of this current at an efficiency of 5 per cent., and loses 4.75 kilowatts of the amount by similar losses and has a useful output of 90.25. The motor is thus short by 9.75 kilowatts of the 100 kilowatts necessary to turn the generator. To obtain this further output we must add 10.263 kilowatts from some external source, for we shall lose 5 per cent. of this added current also. The amount is found by the simple percentage calculation $9.75 = \frac{95\,x}{100}$, x being the added current. Therefore, $x = \frac{9.75}{.95} = 10.263$ kilowatts. We add this amount to the 95 kilowatts we are drawing from the generator, and find a total of 105.263; and, if we multiply this sum by 0.95, we shall obtain exactly 100 kilowatts of motor output of mechanical energy. The amount of current added from an external source is thus the measure of the total loss of the two machines acting respectively as motor and as generator. By the aid of a small dynamo of 10 kilowatts capacity, we are thus enabled to test two large machines of 100 kilowatts each. Where similar machines cannot thus be obtained, a motor must be run on a brake with consequent loss of all the power, or a generator is run on a water resistance, and in either case there is great loss of energy, which means coal and money. The Hopkinson test is thus most useful and economical to manufacturers of electric machines.

The writer then proceeds to describe, somewhat fully, a test for efficiency conducted in this manner, and concludes as follows:

The Hopkinson test is the electrical parallel of a similar hydraulic test. A turbine and a centrifugal pump might be connected on the same spindle. If 100 cubic feet of water were put through the turbine in a given time and only 60 cubic feet ran to waste, the pump returning 40 cubic feet to the source of supply, we should say that the combined efficiency of the two machines was 40 per cent.

FAN BLOWER FOR THE CUPOLA FURNACE.

Abstract from Paper read by R. B. Hayward before the Pittsburg Foundrymen's Association. January 5, 1903.

For a considerable period of time in early foundry practice the blowing engine such as is now used in the manufacture of Bessemer steel and in blast furnaces was used for blowing the cupola, but this was displaced by the rotary or positive pressure blower having rotating impellers. This type of blower held undisputed sway until the development of the centrifugal fan blower. The fan was introduced by Sturtevant about thirty years ago, who was the pioneer manufacturer of blowers in this country and in the world.

There are two general types of fans for moving air, one being the propeller or disk fan, which discharges air in lines parallel to its axis, and the other being the peripheral discharge fan with inclosing case. The disk wheel type of fan is incapable of moving air against any considerable resistance, and is, therefore, without value for the cupola furnace, although well adapted to moving large volumes of air against low pressure.

The peripheral discharge fan is built either as a volume or pressure blower, that is, to discharge a large volume of air against a low pressure, or a small volume against a higher pressure. Both forms are essentially alike, the design being modified to suit its particular requirement. In either case the mechanism consists of a blast wheel made of radial arms having floats fastened to the ends, which present their flat surfaces for moving the air. The wheel is ordinarily inclosed in a case having an outlet, the whole forming a means for directing the blast. The maximum amount of air can be moved with a wheel when it has no case, but this form can only be used for special purposes where it is not necessary to give the blast any special direction. The distinction between a volume blower and a pressure blower is that the former is designed to move a large volume of air at a low pressure, and the latter to move a relatively small volume at a higher pressure, which may be as high as 20 ounces per square inch. The points of difference in construction between a volume blower and a pressure blower having the same diameter of wheel, are that the volume wheel is wider and that the pressure wheel has bridging pieces spaced at short intervals on the periphery between the extremities of the blast wheel arms, their use being to prevent the air rolling back upon itself at high speeds. A pressure wheel is also made as narrow as it can be consistently with a given diameter.

Air is delivered from the tips of a peripheral discharge fan, tangentially by centrifugal force, an equal amount entering at the center of the wheel to replace that discharged. The volume of air delivered varies directly as the speed, the pressure as the square of the speed and the power as the cube of the speed. That is to say, multiplying the speed by two, multiplies the volume by two, the pressure by four, and the power by eight. A thorough understanding of these conditions would often save much trouble for both the purchaser and the salesman. If the speed is increased over that specified, the power required may be enormously increased for a slight increase of speed. In general where a fan has been installed and it afterward becomes necessary to increase the volume of air, it is cheaper and better to put in another fan than to speed up the old one. The pressure required for foundry practice varies from 4 to 14 and 16 ounces per square inch, depending on the size of the cupola.

LARGE STOP VALVES FOR HIGH-PRESSURE STEAM.

Abstract from Paper read by J. H. Gibson before the North-East Coast Institution of Engineers and Shipping,
December 12, 1902.

The author referred to the well-known difficulties encountered in the use of ordinary large stop valves and high-pressure steam, especially the double-beat or equilibrium valves such as are generally used for the throttle valves of locomotives and in the main steam pipes of large marine engines. The construction of these valves, which makes them easy to open, unfortunately introduces a condition favorable to leakage. No matter how carefully the two seats of a double-beat or double-poppet valve are fitted when cold, they will be distorted somewhat out of truth by the heat and pressure of the steam, and the same also holds true of the valve case, so that leakage is almost inevitable, especially with the larger valves. To force such valves to their seats with great pressure is out of the question with man power alone, so on the large ocean liners the main actuating valve is commonly actuated by a separate engine driving worm gearing, the idea being to compensate for the defects of the valve by main force. This, as the author points out, is scarcely mechanical or in accordance with good engineering. He also says that the annoyance of leaky regulating valves is a very real one to the engine room staff of a steamship. It is not always permissible to close the boiler stop valves or even the shut-off valves usually fitted in the main steam pipe at the engine-room bulkhead, as under certain circumstances the engines may be stopped for hours in "stand-by" condition, ready at a moment's notice to move "ahead" or "astern." Consequently the steam is often allowed to leak through the engines; and the cylinder drains must be kept open continuously, adding greatly to the discomfort of the engine-room and increasing the danger of pressure accumulating in the receivers, thus blocking the engines when a sudden call is made.

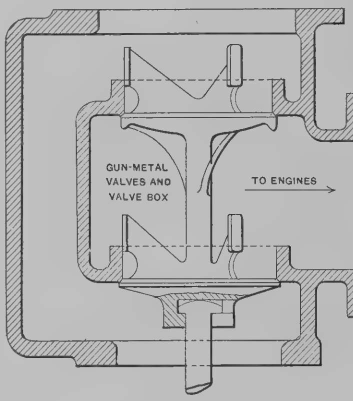


Fig. 8.

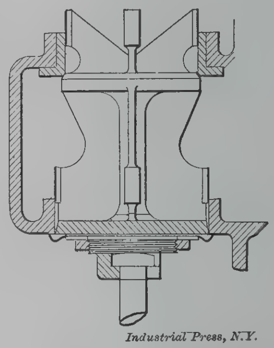
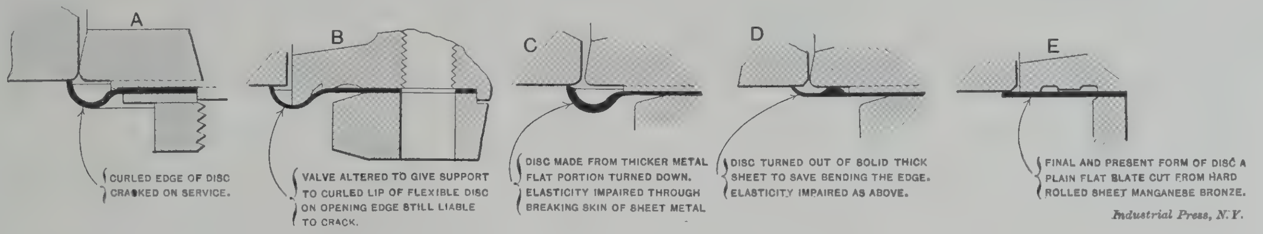


Fig. 9.

Mr. Gibson then described the valve made by his firm for the starboard engines of a torpedo boat destroyer of 6,000 indicated horse power, which was tested alongside of the valve made for the port engines. The valve for the starboard engines is shown in Fig. 9, and its distinguishing feature is a flexible disk of hard-rolled bronze, bearing on the larger seat, the disk for the smaller seat being made solid with the stern as in the usual manner. This valve stood a cold hydraulic test of 500 pounds per square inch and a steam pressure of 250 pounds, with no leakage whatever. The solid disk valve leaked badly with steam, although it was made with care and the seats were jammed down with the aid of a lever. In the improved valve any distortion of the valve or seats is compensated by the flexible bronze disk, which accommodates itself to changes in shape and permits the solid valve disk and seat to close tightly. The larger valve consists of a flexible disk of hard-rolled bronze, the smaller valve being solid and of the usual type. The distance between the valve seats is slightly greater than that between the valves. Consequently, in closing, the flexible valve engages its seat first. The solid valve is then pressed home on its seat by the unbalanced steam pressure acting on the central area of the larger valve, assisted by the handling gear. Any distortion between the valves and seats is thus taken up by the flexible disk, which readily accommodates itself to its seat, leaving the smaller solid valve free to bed itself in its own seat.

In the improved valve, shown in Fig. 9, some trouble was subsequently experienced due to the curled edge of the flexible disk cracking, and various other materials and forms, as shown in *A*, *B*, *C*, *D*, *E*, Fig. 10, were tried, the experiments finally culminating in the adoption of a perfectly flat disk, as shown at *E*, bearing on a raised lip on the valve seat. Should this disk take a permanent set, it may be turned over and used in that position. Apparently the disk retains its flexibility longer when the skin left on by the rolling process remains unbroken. But the amount of spring allowed is reduced to a minimum to relieve the disk of buckling action as much as possible. We find that 1-64-inch of spring is ample in most cases, but this allowance may have to be slightly increased should the valve expand so much more than the valve box that the difference allowed is overtaken. However, a buckling effect of even 1-32-inch in a 12-inch disk is scarcely perceptible, and as the number of changes from flat to buckled is comparatively few and not constantly intermittent, the disk lasts indefinitely.


A
B
C
D
E
CURLED EDGE OF DISC CRACKED ON SERVICE.
VALVE ALTERED TO GIVE SUPPORT TO CURLED LIP OF FLEXIBLE DISC ON OPENING EDGE STILL LIABLE TO CRACK.
DISC MADE FROM THICKER METAL FLAT PORTION TURNED DOWN. ELASTICITY IMPAIRED THROUGH BREAKING SKIN OF SHEET METAL
DISC TURNED OUT OF SOLID THICK SHEET TO SAVE BENDING THE EDGE. ELASTICITY IMPAIRED AS ABOVE.
FINAL AND PRESENT FORM OF DISC A PLAIN FLAT PLATE CUT FROM HARD ROLLED SHEET MANGANESE BRONZE.

Industrial Press, N.Y.

Fig. 10. Forms of Disk Construction tried in Experiments; the one shown at E is the one finally adopted.

KEROSENE AS A DISINCRUSTANT.

L'Echo des Mines et de la Metallurgie, November 17, 1902. p. 1389.

Petroleum oil has been used as a disincrustant for a long time. According to the figures furnished by Mr. Fritz Krauss, the engineer of the Austrian Society of Steam Boiler Owners, in every battery of six boilers one should always be out of commission for cleaning. The loss of heat due to the cooling off and reheating of a boiler amounts to about 1 per cent. of the total annual coal consumption, while the work of cleaning may amount to 3 per cent. of the total cost for coal, to which should be added 2 per cent. for interest while the boiler is out of service, making the total annual cost for the cleaning of the boiler about 6 per cent. of the annual expenditure for fuel. To this it is necessary to add the losses of heat due to incrustation, which may amount to from 4 to 5 per cent. of the fuel account. From this it appears that the cost of fuel is increased from 10 to 11 per cent. through these various causes. And it may be added that, in the case of small plants these expenses and annoyances may be considerably increased.

The use of petroleum oil, however, makes it possible to cut them down very considerably. Its action belongs to the physical-mechanical actions. It prevents the adherence of the deposits to the sheets and makes them soft; in contact with water it forms an emulsion and prevents the agglomeration of the particles of lime. Simply washing serves to clean the boiler. In a boiler that is already coated with scale, it is possible to detach the same by simply injecting petroleum. There are, however, some disadvantages in this, in that a badly cleaned boiler into which kerosene has been injected, or where it has been used before cleaning was done, is apt to cause an overheating of the sheets and perhaps a fire-crack. Thus trouble is experienced chiefly with outside fire boxes. The petroleum oils should, therefore, never be used in boilers having external fireboxes, if the former are coated with a scale. This accident need not be feared when the firebox is beneath as the sheets are much better located with reference to the fire. It is evident that the method cannot be used if a strictly pure steam is required.—G. L. F.

PROTECTION OF SUSPENSION BRIDGE CABLES.

Engineering News, November 13, 1902.

In the *Engineering News* for November 13, is an article by Wilhelm Hildenbrand, engineer for the cables of the new East River Bridge, New York, in which he tells about the waterproof wrapping for the four large cables which are to support the bridge structure. For the past fifty years or more all large wire cables have been protected from atmospheric influences by a method originated by John A. Roebling, the pioneer of wire suspension bridges. At the time of the early bridges built by Roebling, the use of steel for building purposes was unknown, and galvanizing was not invented. Bright iron wire was used which was treated in the following manner:

Each ring of wire was dipped twice in boiled linseed oil, the second dipping being done after the oil of the first dipping was thoroughly dried. These two immersions in oil, after the latter became perfectly dry, surrounded the wire with a gummy film, to which a third coat of oil was added by passing the wire through an oil-saturated sheepskin, when it ran off from the drums for cable-spinning. After a number of wires were united and tied into a "strand" the latter received another thorough soaking of oil, which added a fourth coating and gave assurance that any spot of a wire from which the oil film might have been scraped off during cable-spinning was covered with at least one coat of oil.

A cable in which every wire is prepared as indicated above may be considered tolerably rust-proof for years if kept properly painted, but permanent safety can only be obtained by excluding all moisture from the interior of the cable, which requires a watertight and airtight covering. Such a covering was given by Roebling to all of his cables by a tight and continuous wire wrapping over the whole length of the cable, exempting only those parts which rested in the saddles or passed around the end shoes. The wrapping was put on with a specially constructed machine, worked by hand, preceded by strong clamps which squeezed the bundle of strands into a cylindrical form of the required diameter. The wrapping wire was underlaid with a thick coat of white lead mixed with linseed oil, and a similar coat was applied to the top of the wrapping. After that the cables were painted with metallic or oxide paint of any desired color. The paint was put on thick enough to fill the hollows between wrapping wires, making the surface of the cable practically smooth and giving it the appearance of a solid cylinder. The cables of bridges that have done service for over 40 years have been found to be in a perfect state of preservation when treated by this method.

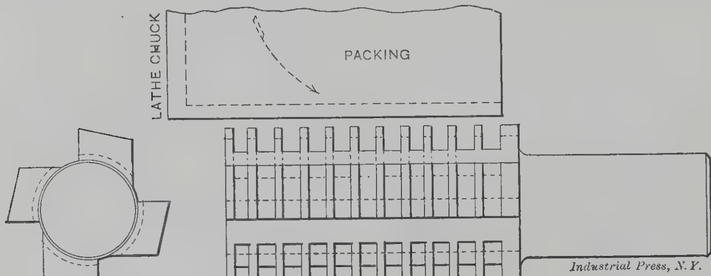
When it came to the construction of the first Brooklyn Bridge which was exposed to salt water air, Mr. W. A. Roebling, the engineer, felt apprehensive about his father's methods of protection and it was decided to have all the wires galvanized. In taking up the description of the work on the new Brooklyn Bridge Mr. Hildenbrand gives an extended account of the various schemes thought of, and of the one finally adopted. The plan of the original Roebling has been found by experiment to work so well and is so simple that it may justly be questioned whether a mistake has not been made in the measures taken for the protection of the cables of the new bridge. While it is unquestionably true that Roebling's method may not be the only satisfactory one, there is nothing to show that the new method is superior. It was planned at first to give the strands two coats of linseed oil and afterward to coat the completed sections of the cable with a patented preparation known as "cable shield." It was then to be clamped and tied with wire wrappings and finally covered again with cable shield. Finally the whole was to be encased in a sheet-iron covering made in sections, bolted together. The cable shield preparation was found to be too stiff to work properly, however, and another patented preparation, a slushing oil, was tried; but it was found that it would not give a permanent and perfect coating as it had a tendency either to evaporate or to deteriorate under the influence of the gases from the stacks of passing steamers. Finally it has been decided to adopt what is known as a cable compound, similar in its nature to a high-grade metal paint. The strands will now be treated first with the linseed oil and then each section of the cable will have the additional coating of slushing oil and graphite above-mentioned and the whole will be wrapped with a heavy coating of duck which is cut into strips and wound around the cable, about as a physician bandages an arm. The durable metal coating is next applied to the duck covering and finally the sheet-iron covering encases the whole.

While it is expected that this method will give satisfactory results, the fact remains that it is more or less of an experiment and that the experiment is being tried on a very expensive structure.

TOOL FOR CUTTING OFF PACKING RINGS.

Railway and Engineering Review. December 20, 1902. p. 905.

The illustration, Fig. 11, shows a multiple cutting off tool used in the shops of the Michigan Central Railroad in making air-pump metallic packing. The tool is tapered so that the rings are cut off consecutively thus avoiding the trouble that would naturally result if all were cut off at the same time.



Industrial Press, N. Y.

Fig. 11.

This tool is used in a small turret head that is set on the tool block of an ordinary lathe, the turret taking the place of the tool-post. The shank of the cutting-off tool fits into one of the holes of the turret. It will, of course, be observed that the tool really consists of four sets of cutters, any one of which may be brought into use as the others become dulled.

* * *

A balloon constructed by the French War Department for crossing the Sahara is to carry six pigeons, whose safe passage will be supposed to show the feasibility of the plan. As the trip may require four or five days, the recording thermometer and barometer have clockwork to operate five days; and a camera, carrying a long strip of film, is so arranged that exposures will be made by clockwork at intervals of fifteen minutes during the time. Leakage is to be balanced by water ballast, released by a valve when the ground is touched by a ball hanging from the car.

* * *

An alloy of 18.87 per cent. aluminum and 81.13 per cent. antimony is, says the *Aluminum World*, a marked exception to the general rule that alloys are more fusible than the least fusible metal they contain. Both aluminum and antimony melt somewhere near 1,160 degrees F., but the alloy melts only at 1,976 degrees F. Most alloys are denser than their constituents; this alloy is less dense. To put the matter into figures to illustrate, 7.07 cubic inches of aluminum alloyed with 12.07 cubic inches of antimony produces 23.71 cubic inches of alloy, or an increase of volume of 4.55 cubic inches.

SUPERHEATED STEAM FOR TURBINES.

Editor MACHINERY:

In the *Engineering Review* of your December number was an abstract of a paper read before the Detroit meeting of the American Street Railway Association upon "The Adaptability of the Turbine to Superheated Steam."

In speaking of the advantage of superheat, from a thermodynamic point of view, the writer of the paper in question assumes that the well-known law of thermal efficiency, that is, $\frac{T_1 - T_2}{T_1}$, is applicable, and uses the temperature of the superheated steam in this expression, implying that it is the measure of efficiency in the case. As a matter of fact this expression—which, of course, is the efficiency of the ideal Carnot cycle—is true only when all the heat is taken in by the working fluid at the *highest* temperature, and *all* rejected at the *lowest* temperature, these two processes being therefore, isothermal. The expression $\frac{T_1 - T_2}{T_1}$ is, then, not even a rough approximation as a measure of the efficiency.

In the cycle of operations, including superheat, by far the greater part of the heat is taken in at temperatures lower than the ultimate temperature of the superheated steam, the greater part, of course, being absorbed in converting the water into steam. It naturally follows, then, that the use of superheated steam is, thermo-dynamically, of but very little advantage, in any class of heat engines. It seems that the knowledge some people have of the steam turbine is that it is a machine consisting of a wheel, a casing around the wheel, and a jet of steam causing it to revolve. If these were its only necessary elements we might admit, with caution, that "the range of superheating is limited practically only by the superheater." It should be remembered that steam at high temperatures not only burns up the lubrication, but destroys the packing of stuffing boxes and has a chemically corrosive effect upon brass and copper. Bearing this in mind and considering that steam is supplied to the turbine in much the same way as to the engine, and that this supply is increased and diminished with the load (thereby involving, of necessity, some form of regulating valve) I think statements of a broad nature like that quoted above should be made less recklessly.

Superheated steam can be considered, then, but little, if any less objectionable in steam turbines than in reciprocating engines. At the same time its thermo-dynamic advantage is no greater and its corrective influence is much less, since the turbine is not possessed of the same faults as the ordinary engine.

The point I wish to emphasize is, that while the use of moderately superheated steam is, in general, beneficial, rather than otherwise, its advantages are liable to be overestimated.

R. M. L.

It is perfectly true, as our correspondent states, that there is little thermo-dynamic gain from the use of superheated steam in an engine cylinder. The increased efficiency due to superheated steam comes from the reduction in initial condensation and consequent re-evaporation. In the steam turbine there is no alternate heating and cooling of the surfaces in contact with the steam, and no condensation from this cause; yet there is an advantage from the use of superheated steam in turbines, as shown by many tests. Mr. Parsons estimates that 90 degrees superheating will reduce the water consumption of a turbine about 12 per cent. and recent tests of a De Laval turbine show a saving of nearly 9 per cent., with 84 degrees superheating. While we know of no experiments to show just why this saving is effected, it may be due, in part at least, to the increased velocity at which the superheated steam would impinge against the blades of the wheel. It does not appear to us that there need be serious trouble in lubricating the admission valves of a steam turbine using superheated steam, and we believe, contrary to our correspondent, that the turbine is admirably adapted for superheated steam. In fact, Mr. E. H. Foster testifies in an item to be found in the "Engineering Review" of this number that there need be but little trouble in a steam engine cylinder, if the oil is introduced into the cylinder direct, instead of with the steam in the usual way.—Editor.]

STEEL AND ITS TREATMENT.—6.

CASEHARDENING.

E. R. Markham.

The subject of casehardening is one that receives even less consideration in the average shop than the hardening of tool steel, if that be possible. According to the generally accepted idea of the process, it consists essentially of making the outside of a piece of wrought iron, or of machine steel hard while the interior remains soft. Speaking narrowly, this is true; but if properly understood, casehardening requires as much study, and calls into play the reasoning faculty to fully as great an extent as the hardening of tool steel. Formerly when wrought iron was used if articles required simply a surface the hardening operation was simple, compared with the present where a low grade of steel is used, because it is cheaper and is less costly to machine, and if properly treated answers the purpose much better than wrought iron.

The method commonly used when hardening articles such as screws, nuts, etc., which simply require sufficient surface hardening to save tearing out the edges of screw driver slots, or to keep the corners of nuts from becoming rounded or mutilated, consists in heating the article red hot, sprinkling on it a little cyanide of potassium, or yellow prussiate of potash. Now place the article in the fire again, heating to the desired temperature and quenching in a bath of clear water, brine, oil or any liquid that will absorb the heat quickly. This method is extensively used and answers where but a few pieces are hardened, but is very unsatisfactory and costly for many pieces.

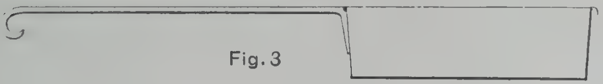


Fig. 3

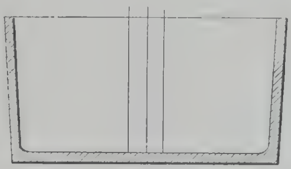


Fig. 1

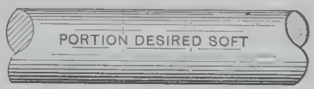
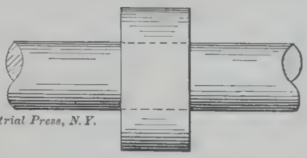


Fig. 5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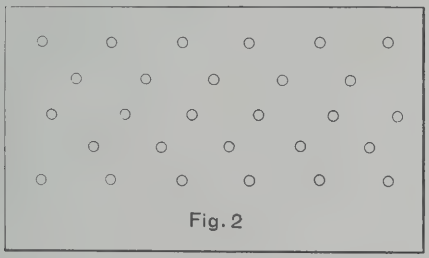


Fig. 2

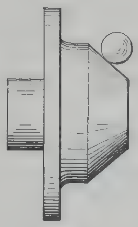


Fig. 4

As it is necessary oftentimes to harden a few pieces by this method, a hint may not be amiss. For best results use *chemically* pure cyanide of potassium. Pulverize it, and keep it in a tin or sheet-iron box having a perforated lid, the object of the perforated lid being that the cyanide may be sifted onto the work in any desired quantity. If colors are desired on the hardened article it will be necessary to polish the surfaces nicely and have them free from grease or dirt; for while the grease would burn when the article is heated, the surface would be stained and consequently would not color nicely. When colors are wanted, it is necessary to use clear water; that is, clean. Soft water produces better colors than hard water. Work cannot be colored if dipped in dirty or greasy water.

If especially nice colors are wanted they may be obtained by following the directions herewith: When the work is ready to dip, place a piece of ¼-inch gas pipe in the bath with its end nearly at the bottom of the bath. Blow through the pipe, passing the work down through the mixed air and water; for while work that needs coloring should not be exposed any longer than necessary to the action of the atmosphere, yet the injection of air into the hardening bath results in the most beautiful colors imaginable. Another factor that must be considered if colors are wanted is the means of heating. If the article is heated in a dirty fire pretty colors cannot be obtained. If the article is exposed to the products of combustion in the fire, or the oxidizing action of the air, colors cannot be obtained, or at least, not as pretty colors as when the article is heated in a tube, a muffle furnace or some receptacle that removes it from the influences mentioned. Where a number of small articles that require coloring are to be hardened, melt and bring to a red heat, in a small iron dish, a sufficient quantity of cyanide of potassium to permit immersing several pieces of work at a time. These may be allowed to remain in the molten cyanide for a length of time that insures satisfactory results; the longer the articles are in the cyanide the deeper will be the hardened surface. When they are ready to quench, remove and plunge in the bath as mentioned. Many shops have large cast-iron or wrought-iron crucibles, heated by fires specially designed for the purpose. The work, if large, is suspended in the cyanide by means of wires, which are made in the form of a double hook, one end of which passes around the work, or through some hole in it, and the other end projects over the upper edge of crucible. It will be seen that in this manner quite a number of pieces may be suspended in the crucible at a time. Where much of this class of work is done it is advisable to dispose in some manner of the fumes of the molten cyanide, as they are very injurious to the health. The reader must bear in mind that cyanide of potassium is a *violent poison* and extreme care should be exercised when using it. Cyanide of potassium, unlike lead, is lighter than iron or steel and consequently articles placed in it sink to the bottom instead of floating on its surface, as is the case with lead; for this reason the pieces are suspended by means of wires, or placed in wire cloth baskets. These baskets must be made of *iron* wire. Do not use galvanized wire, or wire with any form of lead or any metal whose fusing point is so low that it will melt at the heat to which the articles are subjected; otherwise the metal will fuse and deposit itself on the work, thus ruining it. From the foregoing it will also be readily understood that no solder should be used in constructing the basket.

If the basket holding the work is dipped in the water it must be thoroughly dried before being placed in the molten cyanide, or the moisture will cause the cyanide to fly, and this, owing to the poisonous nature of the chemical, will produce a very sore burn wherever it strikes the flesh. The same care must be exercised when using the hooks, which should be thoroughly dried before placing in the molten mass. When work is hardened in large quantities by this method it is necessary to provide extra hooks and baskets, to avoid delay while the moistened ones are drying. This method is used quite extensively for casehardening steel of low grade, and still more commonly for heating articles of tool steel for hardening. In many shops it has supplanted the crucible of red hot lead as a means of heating taps, reamers, and similar tools.

The more common method of casehardening, for work in large quantities, consists in packing the articles in iron boxes with carbonaceous materials, placing in a furnace and subjecting to heat for a sufficient length of time to insure the penetration of carbon to the desired depth. The carbonizing element most commonly used is granulated raw bone. This is used either alone or with an equal quantity (volume) of granulated wood charcoal. It is customary in many shops to place the box of work in the oven or furnace, leaving it there a certain length of time. This method is open to serious objections, for some days the furnace will heat more readily than others, or the box of work will not absorb heat as quickly one day as it will another. Consequently uneven results follow. In order to insure uniform results the writer, for many years, used a system of test wires, which he found furnished a reliable means of ascertaining when the box was heated through. A half dozen ¼-inch holes are drilled through the center of the cover of the hardening box, and through these holes a piece of 3-16-inch wire is placed, the wire reaching to the bottom of the box and projecting about one inch above the top of cover, as shown in Fig. 1. When the box has been subjected to heat for a length of time (according to one's judgment) to become heated through, one of the test wires is removed by means of a pair of long tongs, or a pair of ordinary length, with a piece of gas pipe slipped over each leg to give desired length. If the wire shows red, time from then; if not, wait a few minutes and draw another, and so continue until one is drawn that shows red its entire length.

As previously stated, the subject of casehardening and its possibilities are very imperfectly understood by the average mechanic. A hardened surface is not the only thing desirable at times. If the work simply requires a hardened surface to resist frictional or similar wear the operation is comparatively simple, provided the strength of the piece is not to be considered. In such cases the articles are packed in a box with granulated raw bone and charcoal, in equal quantities, and run in the furnace for a sufficient length of time to carbonize to the depth desired. Then the box may be removed from the furnace and inverted over the bath, provided the pieces are of a size and shape that insures their becoming sufficiently chilled before reaching the bottom of the tank. Should they be too large for this to be accomplished it is advisable to wire them before placing in the hardening box. They may then be removed from the box by means of the wires and immersed in the bath, moving the work around in the bath to bring it in contact with the cooler portions, and thus prevent a cushion of steam from keeping the liquid away from the work. If the pieces are small they may be dumped directly into the bath, but in such a manner that the contents of the box will not go into the bath in a mass, or the liquid will not act on the surface of the iron. The work may be sifted out of the box, or wires may be arranged to scatter the work, as shown in Fig. 2.

Should the article be somewhat slender or weak, and it be desirable to get a hard surface and a tough interior, it may be packed in a box as described, using a mixture of equal parts of charred leather and granulated charcoal. Run as described, and quench in a bath of raw linseed oil. If the articles are large it will be necessary to wire them, dipping in the oil by means of the wires; if small, the contents of the box may be emptied into a sieve having a handle, as shown in Fig. 3. This sieve must be made of sheet iron throughout to prevent its catching fire from the red hot pieces of work. The packing material will fall through the perforated bottom and the work may be dumped from the sieve into the oil. The object in using charred leather in preference to bone, for work that must be strong, is that bone contains phosphorous which is taken up by the iron or steel and this, while it is a hardening element, causes the steel to become exceedingly brittle, especially when in combination with carbon. Where the pieces must be quite tough, but no great strength is required, bone may be used. Dump in oil. If extreme surface hardness is desired, without having the piece brittle, pack in charred leather and dump in water. When hardening screws made of Bessemer steel wire, it is advisable to use expended bone—bone that has been used before—rather than raw bone. This will cause the work to be hard enough without being brittle, as when raw bone is used. If colors are desired it is advisable to char the bone *before* using, which may be done by filling an iron box with raw bone, placing the cover in position and sealing with fire clay. After this has thoroughly dried, place the box in the furnace, allowing it to remain until the contents are charred. If the furnace is large the box may be put in when the day's work has been removed and the fire extinguished; for the walls of the furnace will in all probability retain the heat long enough to accomplish the desired result. Should the furnace walls be light, however, and not capable of retaining sufficient heat the fire must be run for a sufficient time to char the bone the desired amount. Articles packed in charred bone will not be as brittle as when raw bone is used.

When packing work in the box, place about 1½ inches of packing material in the box. On this put a layer of work, keeping the pieces about ½-inch from one another in the box, or 1 inch from the walls of the box at any point. Cover the layer of work, to a depth of ½ inch, with the packing material, working it well between the pieces, and tamp down. Now put in another layer of pieces, and so continue until the box is filled to within 1½ inches of the top, when the box may be filled with the packing material. Put the cover in position, seal the edges with fire clay mixed with water to the consistency of dough, but before putting the box in the furnace run the test wires down through the holes to the bottom of the box. Carbon is supposed to penetrate iron at the rate of about ⅛-inch in 24 hours. Therefore, in order to harden to the depth of 1-32-inch it would be necessary to subject the article to heat for six hours after it was red hot. This can be ascertained by means of the test wires.

Selection of Stock.

A factor which should receive the greatest consideration, and which seldom gets any, is the stock that must be used to obtain certain results. If a hard surface is the only thing to be considered, almost any stock will do. If, however, the article is to be subjected to great strain, it is essential to select a stock low in percentage of harmful impurities, and containing carbon in the proper proportion to harden the article sufficiently to make it capable of resisting the strain to which it will be subjected. The extra surface hardness required may be procured by the steel absorbing sufficient carbon from the packing material to produce the desired result. Articles which must resist shocks, blows, or strains of any character should be made from open-hearth steel rather than from Bessemer steel; the former runs much more uniform as regards percentage of impurities.

When the article to be hardened must resist the action of blows, harden it in a manner that will produce a fine compact grain; it will stand up much better thus than if the grain were open. This can be accomplished by packing the articles as described, letting them run the necessary length of time to allow the carbon to penetrate to the desired depth. Then the boxes may be taken from the furnace and allowed to cool off. When cool, the articles may be removed and hardened in the same way as those made of tool steel—by heating separately in the open fire, or by being heated in red hot lead, or being placed in a box without any carbonizing material, heated to a low red and dumped in the bath. The second heat, without carbonizing material, produces the fine grain. In this manner a low grade steel may be given a grain as fine as the nicest tool steel. This process is familiarly known as the Harveyizing method. It is used where the surface is subjected to the action of blows, or where a small portion of the surface is to be subjected to pressure or wear. Take, for example, the surface of a bicycle cone such as shown in Fig. 4, where the ball bears on a very minute portion of the surface. If the cone is made of a low-grade steel and hardened by the method familiarly known as casehardening, the grain of the steel is open, and consequently when the ball bears on the surface over one of the pores, the wall caves in, leaving the small hole in the surface. It is supposed by many that these holes are caused by the ball picking up pieces of steel that compose the surface of the cone. Such, however, is not the case; the surface caves in, not having any backing, but when the grain is compact this cannot happen. When cutting tools are made from machinery steel it is best to pack the work in charred leather, running them for a sufficient time, allowing them to cool and proceeding as previously described. The grain will be fine and compact, and the tool hard and strong. The writer does not advocate the use of a low-grade steel in place of tool steel for tools, but claims, from experience, that many times excellent results follow if care is used in selecting the steel, and if the directions given are followed.

When it is considered necessary to harden a portion of an article and leave the balance soft, it may be accomplished by protecting the portion to be soft with something that will prevent the carbon from coming in contact with the steel at that point, as steel cannot harden unless the surface is carbonized. The portion that is not protected will become carbonized, and consequently will harden if plunged in the bath when red hot. There are various methods pursued when a portion is not to be hardened. A very common one consists in placing a collar over the portion, as shown in Fig. 5, which, however, is a very costly method when many pieces are to be hardened. Another consists in protecting the surface with fire clay mixed with water, adding a sufficient quantity of plasterers' hair to hold the mass together. Sometimes the piece is subjected to the action of carbon on its entire surface; but the portion that is desired soft is covered to protect it when dipped in the bath. In this case the surface is carbonized but does not harden, because it is protected from the cooling action of the water. As an example, take the crank axle shown in Fig. 6. The axle is subjected to the action of carbon in the usual manner. In order to insure fine grain in the portion where the ball is to run, the axle is not hardened at the heat the steel is carbonized at, but is given the second heat to refine the grain. The axle is taken with the tongs shown in Fig. 7, which effectually protect the enclosed portion from the cooling action of the bath.

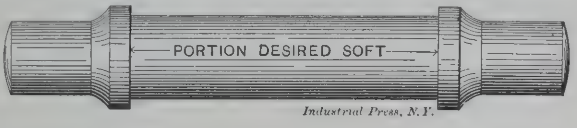


Fig. 6.

Another method used in local casehardening consists in machining to size the portions that are desired hard, before carbonizing, leaving the balance of the piece large. It is then carbonized and allowed to cool, after which the balance of the piece is machined to size and the article is heated and quenched in the bath. The parts that were machined to size before carbonizing will become hard, while the other portions having been machined below the carbonized surface will be soft. As an example we will consider the axle shown in Fig. 8. It is first machined as shown in Fig. 9. Then it is carbonized and machined to size, as represented in Fig. 8. After being machined to size it is heated red hot and dipped in the bath. The portion turned off after carbonizing will be soft while the balance will be hard.

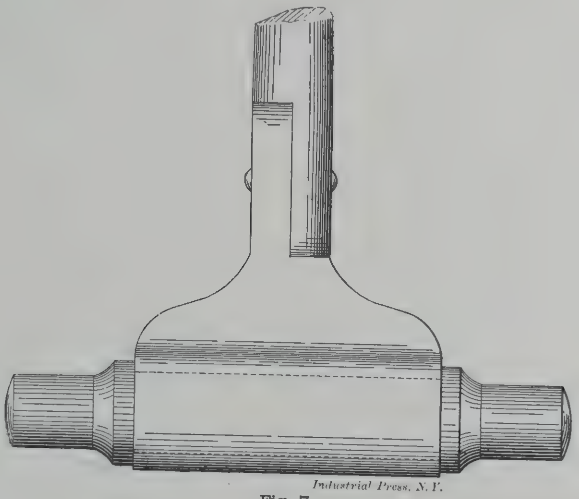
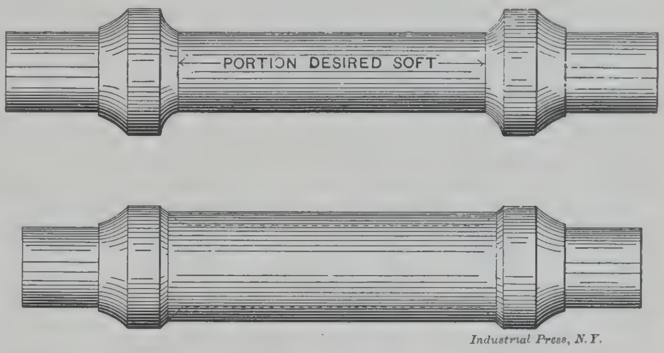


Fig. 7.

Still another method which works very nicely but is not generally used on account of its cost, consists in plating with nickel the portion desired soft. As carbon cannot penetrate nickel the plated portion will be soft while the balance of the article will be carbonized and consequently will harden when dipped in the bath.

When bone is used as the carbonizing element it should be saved and dried, for it can be used again for hardening small articles and pieces which need not be very hard. It can also be used for work that must be hard by adding an equal quantity of raw bone. Leather that has been used should also be saved, as when mixed with an equal quantity of fresh material it works even better than the fresh material used alone.

Granulated raw bone may be purchased of any size granule. The small sizes are used for work that is not to be subjected to heat for a very long time. The deeper the hardened surface must be, the longer the article must be exposed to the action of heat and consequently the coarser the bone should be. When articles require hardening very deep it is advisable to use a coarse bone and run for 10 or 12 hours. Then allow it to cool, repack with fresh material and run for an equal period again. This is preferable to the method of exposing the heat for too great a length of time at once. If extra good results are required it is advisable to use bone-black instead of raw bone. This is a prepared form of bone that has been charred and ground and gives off its carbon very readily. Still better results are obtained by the use of hydrocarbonated bone, which is a form of bone-black treated with oils.



Figs. 8 and 9.

Charred leather may be purchased in the open market. It is apt to be anything but reliable, however. Best results are obtained if the leather is charred in the factory. Do not use thin, light pieces as there is nothing good in such material; the very best leather for this purpose is to be had from some shoe factory. Get the scraps left after soles are punched; this scrap is heavy, and furnishes a satisfactory material. Fill a hardening box with the scrap; put on the cover and seal. The box is then placed in the furnace and the leather charred in the same manner as when charring bone. Care must be taken not to overdo it; it should be charred just enough to pound up well.

The granulated charcoal referred to may be obtained by pounding common hardwood charcoal. The most satisfactory charcoal, however, is to be obtained in the market, because the kernels are all of one size, and when the cost of pounding is taken into consideration the commercial article is the cheaper.

* * *

The *Electrical Review* (London) says that a piece of old blueprint paper can be used to determine the positive and negative poles of an electric wire. All that is necessary is to moisten the paper and apply it to the terminals of which it is desired to determine the polarity. In a few seconds the blue paper will be bleached in the vicinity of the negative terminal.

Census Bulletin No. 247, "Power Employed in Manufactures," states that the aggregate power employed in manufacturing establishments of the United States during 1900, was 11,300,081 H.P.; in 1890 it was 5,954,655 H.P.; in 1880, 3,410,837 H.P.; and 2,346,142 H.P. in 1870. Of the total power used in 1900, steam engines furnished 8,742,416 H.P.; water wheels, 1,727,258 H.P.; electric motors, 311,016 H.P.; gasoline engines, 143,850 H.P.; and other sources, 54,490 H.P.

LETTERS UPON PRACTICAL SUBJECTS.

A HANDY CENTERING TOOL.

Editor MACHINERY:

The little tool shown in Fig. 1, which I call a centering scale, has been found very handy for locating the centers in the ends of a piece of work. It is cut from sheet steel about 1-32-inch in thickness, and no great accuracy is required in its construction. It may be marked out with a scratch awl and then filed down to the lines. The heights of the different steps are but one-half of the numbers which are stamped upon them, the numbers being simply to indicate the diameter of the stock for which each respective step is used. The steps, therefore, rise but 1-16-inch and are about ½-inch wide.

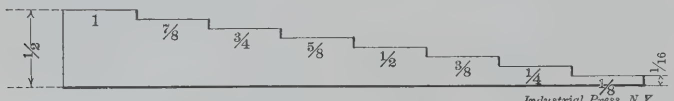
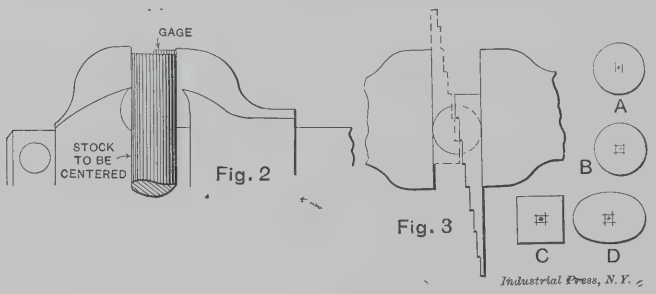


Fig. 1. The Center Gage.

The method of using the gage is shown in Figs. 2 and 3. The stock to be centered is put in a vise so that the jaws project about ¼-inch above the top of the work. The gage is laid upon the work with the long side resting against one of the vise jaws. Having selected the step which appears to be nearest to the center of the stock, a line is scribed upon the stock, using the edge of this step as a guide. The gage is then turned around with the long edge resting against the other vise jaw, as shown by the dotted lines in the same figure, and another line is scribed upon the stock, guided by the same step that was used before. We now have two parallel lines scribed upon the stock as shown at *A*, Fig. 3, and if the step which was nearest to the center has been used these lines cannot be over 1-16-inch apart. It will sometimes happen that the step nearest the center will be beyond it, instead of below it as it was in the illustration used, so that the scale, when placed in position for drawing the second line, will overlap the first line drawn but the result will be the same. When these two lines have been drawn the work is turned around one-quarter of a revolution and two more lines are drawn in the same manner, thus forming a square as shown at *B*. As this square is never over 1-16-inch, its center, and consequently the center of the stock, is readily located by the eye. *C* and *D*, in the same figure show the application of the gage to centering square and oval stock. B. W. FRANK.



Figs. 2 and 3. Uses of the Center Gage.

LARGE VS. SMALL UNITS.

Editor MACHINERY:

In a recent issue of your journal one of your correspondents was making quite a rational objection about measurements of some importance being taken in inches instead of feet and yards. I think he is quite right, but I should say the same objection can be raised against heavy weights taken in pounds instead of tons. Most of the time a steam engine, a fly-wheel or a dynamo are estimated in so many thousand pounds while the same weights expressed in tons of 2,000 pounds would certainly bring a clearer idea of the statement to the mind of the reader.

To say, for instance, that a piece of machinery is weighing 500,000 pounds is just like expressing the distance from New York to Chicago in yards or feet instead of miles. In the case referred to, it would indeed be just as intelligible, if not more, to say that the machine weighs two hundred fifty tons (250 T) besides being quicker to spell and write.

An objection of the same kind can be extended to electrical measurements. In these days of long distance transmissions at high tension, it is quite common to hear about electric currents of 30, 40 or 60,000 volts. Why not say 30, 40, 50 "kilovolts." The prefix KILO means one thousand, just as the word "kilowatt" stands for 1,000 watts; it would be only a matter of a very short time to get used to the new unit, which in the end has nothing in itself so very strange as to prevent its adoption. As for the tons instead of pounds it is only a matter of convention. EDW. C. CHODZKO.

Haiphong-Tonkin, China.

A SPECIAL TURRET LATHE TOOL.

Editor MACHINERY:

A short time ago we were making the pieces shown in Fig. 1, which are of brass and go on the ends of water filters. These pieces were tapped at *A*, while at *B* they were counterbored, as shown, to allow the insertion of a wire screen disk and a felt washer. The work was done on a turret lathe and the principal problem was to design a tool that would cut the recess *B*. Fig. 2 shows the tool that we made for this purpose. *C* is the body of the tool which was grooved to hold the four cutters *D D*. These were turned and ground to the proper diameter for boring the hole to tapping size. The check collars were threaded on the back end to take the thrust of the cutters. A hole was drilled for the shank of the circular cutter F and the back end of this was fitted with the handling lever *G*. The circular cutter was cut away as shown so that when the lever was in its normal position, lying against the shank, the cutting edge cleared the work. In operation the tool was run in to the casting until it reached a stop. The lever *G* was then raised until the cutter ceased to cut, the handle then dropped to its original position and the tool was withdrawn. There now remained only to tap the hole and this was accomplished in the usual manner. In making this tool it was of course important that the circular cutter should be of just the proper diameter to cut the recess to the required depth. NIX.

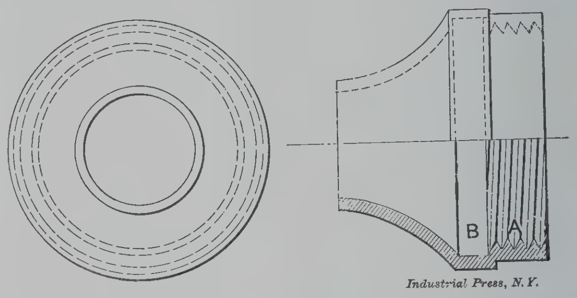


Fig. 1. One of the Pieces to be Machined.

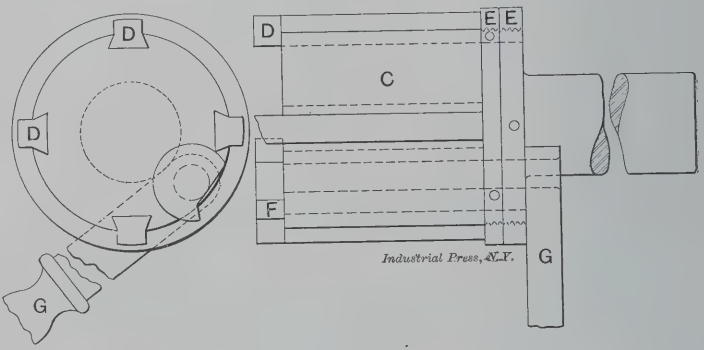


Fig. 2. Turret Tool for Boring and Recessing.

Hartford, Conn.

GEOMETRICAL PROGRESSION.

Editor MACHINERY:

In designing such machine tools as lathes, milling machines, boring mills, etc., it is customary to arrange the speeds and feeds in geometrical progression, that is, each successive feed or speed is increased by the same multiplier at each step, as: 1, 2, 4, 8, or 3, 9, 27, etc. The common multiplier is called the ratio. For any one designing tools in this way the accompanying table may be of value, particularly to those who are unfamiliar with the use of logarithms. The table explains itself, yet may be made clearer by a few examples.

TABLE OF GEOMETRICAL PROGRESSION.

Ratio.	Increase in per cent.	Number of Spindle Speed or Feed from Slowest to Fastest.																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1.10	10	1	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2 14	2.36	2.59	2.85	3.14	3.45	3.80	4.18	4.60	5.05	5.56	6.11	6.73	7.40	8.14	8.95
1.15	15	1	1.15	1.32	1 52	1.75	2.01	2.31	2 66	3.06	3.52	4.05	4.65	5.35	6.15	7.08	8.14	9.36	10 76	12.38	14.23	16.37	18.82	21.65	24.89
1.20	20	1	1.20	1.44	1.73	2.07	2.49	2.99	3.58	4.30	5.16	6.19	7.43	8.92	10.70	12.84	15.41	18.49	22.19	26.62	31.95	38.5[illegible]	46.01	55.21	66.25
1.25	25	1	1.25	1.56	1 95	2.44	3.05	3.81	4.77	5.96	7.45	9.31	11 64	14.55	18.19	22.74	28.42	35.53	44.41	55.51	69.39	86.74	108.40	....	....
1 30	30	1	1.30	1.69	2.20	2.86	3.71	4.83	6.27	8.16	10.61	13.79	17.92	23.30	30.29	39.37	51.19	66.54	86.50	112.50	....	....	....	....	....
1.35	35	1	1.35	1.82	2.46	3.32	4.48	6.05	8.17	11.03	14.88	20.09	27.14	36.64	49.47	66.78	90 37	121.70	....	....	....	....	....	....	....
1.40	40	1	1.40	1.96	2.74	3.84	5.38	7.53	10.54	14.76	20.66	28.93	40.50	56 69	79.37	111.10	....	....	....	....	....	....	....	....	....
1.45	45	1	1.45	2.10	3.05	4.42	6.41	9.29	13.48	19.54	28.33	41.09	59.57	86.38	125.30	....	....	....	....	....	....	....	....	....	....
1.50	50	1	1.50	2.25	3 38	5.06	7.59	11.39	17.09	25.63	38.44	57.67	86.50	129.80	....	....	....	....	....	....	....	....	....	....	....
1.55	55	1	1.55	2.40	3.72	5.77	8.95	13.87	21.49	33.32	51.64	80.04	124.10	....	....	....	....	....	....	....	....	....	....	....	....
1.60	60	1	1.60	2.56	4.10	6.55	10.49	16 78	26.84	42.95	68.72	110.0	....	....	....	....	....	....	....	....	....	....	....	....	....
1.65	65	1	1.65	2.72	4.49	7.41	12.23	20.18	33.30	54.94	90.65	149.6	....	....	....	....	....	....	....	....	....	....	....	....	....
1.70	70	1	1.70	2.89	4.91	8.35	14.20	24.14	41.03	69.75	118.60	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.75	75	1	1.75	3.06	5.36	9.38	16 41	28.72	50.27	87.96	153.90	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.80	80	1	1.80	3.24	5.83	10.50	18.90	34 01	61.22	110.20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.85	85	1	1.85	3.42	6.33	11.71	21.67	40.09	74.17	137.20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.90	90	1	1.90	3.61	6.86	13.03	24.76	47.05	89.39	169.80	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.95	95	1	1.95	3.80	7.41	14.46	28.20	54.98	107.2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2.00	100	1	2.00	4.00	8.00	16 00	32.00	64.00	128.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Suppose we have a four-stepped cone and wish to make the entire ratio about 4 to 1. We find in the fourth column of the table a value of 4.10. The ratio between two adjoining speeds is given as being 1.6. The back-gear ratio in this instance should be 6.55.

Suppose now that we want 16 feeds, the fastest to be 28 times the slowest. The ratio between two adjoining feeds should then be 1.25, or an increase of 25 per cent.

D. Ag. Engstrom.

DISCUSSING THE METRIC SYSTEM.

Editor Machinery:

The recent discussion before the A. S. M. E. of the pros and cons of the metric system brought to light a considerable amount of information on the subject. One phase of the discussion dealt with the value of the metric system to machine tool builders who may desire to extend the export trade in their products. It was pointed out that by adopting the metric system of measures and applying them in the construction of his product, the machine tool builder would take one important step toward meeting the requirements of his foreign customers and would be benefited accordingly. On the other hand it was contended that by far the greater part of the machinery sold abroad was of standard construction, proving that a change in our system of measures is not called for.

CONVERSION OF SCREW THREADS FROM ENGLISH TO METRIC.

Lead Screw Four Threads per inch.

Threads per inch.	Stud.	Screw.	Pitch of Thread in Millimeters. Compound Gears Used.		
			20/127	40/127	80/127
1	96	24	4.000	8.000	16.000
2	48	24	2.000	4.000	8.000
3	36	27	1.333	2.666	5.333
4	48	48	1.000	2.000	4.000
5	48	60	.800	1.600	3.200
6	48	72	.666	1.333	2.666
7	48	84	.571	1.142	2.284
8	48	96	.500	1.000	2.000
9	48	108	.444	.888	1.777
10	24	60	.400	.800	1.600
12	24	72	.333	.666	1.333
14	24	84	.285	.571	1.142
16	24	96	.250	.500	1.000
18	24	108	.222	.444	.888

It is, of course, true that whether a machine was made after a drawing dimensioned in English measure or metric measure makes very little difference to the man who is using it. Feed screws, and lead screws, however, require a modification of the above statement. Since the work of these screws bears a fixed relation to the system of measures to which they were made, to make them available for a different system of measurement we must have a translating device. The process is analogous to expressing a thought in different languages. It is this process of translating the two systems of measures, and the facility of its accomplishment with most classes of machine tools that it is desired to illustrate here.

To begin with, let us look up a metric conversion table. One of the prominent figures on any such table is 25.4. Twenty-five and four-tenths millimeters equals one inch. To cut a metric screw on an ordinary lathe of American make obviously requires at least one gear, the number of teeth in which is divisible by 25.4. A gear of 127 teeth is the smallest that will answer our requirements, and this same gear is, as will be seen, the key to the whole situation.

Now to take a practical example, suppose that we have an American lathe whose lead screw has four threads per inch, and that we wish to cut a thread whose pitch is one millimeter. We know that with the spindle and the lead screw revolving at the same rate four revolutions of the spindle will advance the tool carriage one inch or 25.4 millimeters. One revolution will advance the carriage $\frac{25.4}{4} = 6.35$ millimeters. It is clear that in order to secure a carriage travel of one millimeter for every revolution of the spindle, the latter must revolve 6.35 times as fast as the lead screw. In other words, we must use two gears whose ratio is 1 : 6.35. But dividing 127 by 6.35 gives 20 exactly. So that to cut the required thread we need but mount our 20 gear on the stud, the 127 gear on the lead screw and the transformation is effected.

Furthermore, if we use the two gears 20 and 127 as compounding gears on the studplate, thereby leaving the stud and the lead screw free for the use of the ordinary change gears, the lathe becomes, for all practical purposes, a lathe with a metric lead screw. How this is accomplished is, perhaps, more plainly shown by the table on the preceding page.

The same method applied to lathes with lead screws of 5, 6, 7, and 8 threads per inch will give us 25-127, 30-127, 35-127, and 40-127 respectively as translating gears to be used in the same manner to get similar results.

Now let us turn to the milling machines in general. The graduated disks on the ends of the feed screw are familiar to us all. They are usually made to read in thousandths of an inch. To convert any English feed screw into a metric screw, with divisions reading in millimeters or fractions thereof it is but necessary to use a disk divided into 127 equal parts. A little arithmetic will show that one division of such a disk when used in connection with a feed screw of three threads per inch, will represent a movement of the slide equal to .066 (sixty-six thousandths) millimeters; when used in connection with a screw of four threads per inch it shows a movement of .05 (five hundredths) millimeters; and when used with a screw of five threads per inch it indicates .04 (four hundredths) and so on.

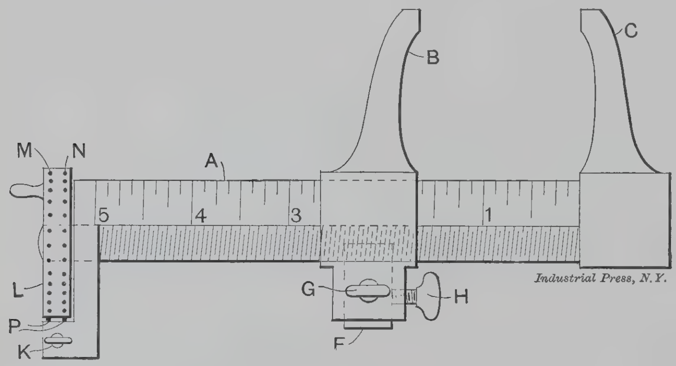
Why, under the circumstances, the foreign buyer should risk the delay and the additional expense connected with extras (such as furnishing metric screws is apt to incur) does not seem clear. Nor can the present system of measures, in the light of the foregoing, be considered as a serious handicap to the further development of our export trade in machine tools. JOHN M. BARNAY.

Cincinnati, Ohio.

AN ANCIENT MICROMETER.

Editor MACHINERY:

The accompanying sketch shows what I believe to be the oldest micrometer in existence. It was made by Henry Frost in Portland, Maine, over fifty years ago, and its accuracy compares favorably with the more modern micrometers. Considering the crudeness of the tools with which this micrometer was made it is quite a remarkable instrument.



Micrometer made over Fifty Years ago.

It consists of a bar, *A*, ½ inch square, with a fixed jaw *C* and a movable jaw *B*. Under the bar is a ⅜-inch screw having sixteen threads per inch. The movable jaw is provided with the half nut F which is thrown in and out of mesh with the screw by means of the thumb screw *G* and securely locked in either position by the screw *H*. The beam being graduated in eighths it is only necessary to set the movable jaw upon the eighth mark nearest the desired measurement and then revolve the wheel *L* in order to obtain the fine adjustment. The face of this wheel has two rows of holes, *M* and *N*, and below will be seen two pins, *P*, which are so arranged that when the thumb screw *K* is moved to the right one of them engages the outer row of holes, and when it is moved to the left the other pin engages the inner row of holes. As the row *M* contains 40 holes, a movement from one hole to another will cause a movement of the sliding jaw of about .0015 inch, or a movement of ten holes will move the jaw exactly 1-64 inch, and a full revolution 1-16 inch. The inner row contains 21 holes so that the movement between two holes advances the jaw 1-336 inch, or a revolution of 7 holes would produce a movement of 1-48 inch, 14 holes would produce a movement of 1-24 inch, 28 holes 1-12, etc.; 1-3 inch would be obtained by revolving the wheel 112 holes. These fractional divisions are employed but little at present for fine measurements, but perhaps they were used more frequently in the early 50's. H. K. G.

Portland, Me.

EQUIVALENTS OF THE METER

Editor MACHINERY:

The following is a list of measures of length which are used in Germany and its borders. You will notice by this what a mix-up there is yet, after the adoption and use of the metric system for twenty-five years.

In all the states, with the meter, you will find the old standards still in use.

This table gives nearly the equivalent number, in inches, required to make a meter:

London	$39\frac{3}{8}$	inches	= 1	meter.
Rheinland	$38\frac{7}{32}$	"	"	"
Hamburg......................	$41\frac{15}{16}$	"	"	"
Wien (Vienna)................	$37\frac{11}{32}$	"	"	"
Sachsen (Saxon)	$42\frac{3}{8}$	"	"	"
Braunschweig.................	$42\frac{3}{32}$	"	"	"
Bayern (Bavaria)..............	$41\frac{3}{24}$	"	"	"
Paris.........................	$36\frac{23}{24}$	"	"	"
Hannover......	$41\frac{1}{8}$	"	"	"

Newbrandenburg, Germany. A. J. D.

HARDENING AND TEMPERING A DIE—A CRITICISM.

Editor MACHINERY:

I was very much interested in Mr. F. E. Shailor's article on forming dies and the use of rubber in connection with them, and I must confess that I have been benefited by the same as well, as the use of rubber as a forming base was quite new to me. It appears to me, however, that some of the points advocated by him in making the dies are, to say the very least, open for discussion. Mr. Shailor states, that the die after immersing in the bath should be held in one place, in order to prevent its warping. It has always been my experience that a die, especially if it be heavy, does not attain that degree of hardness when held in one place that it does when constantly moved about. The reason for this is obvious, because the water surrounding the die becomes heated and does not chill the surface to any great extent. If, on the other hand, the position of the die is gently but constantly changed, the water in the immediate neighborhood is always cold, thus causing a deep chill. As the correspondent's main object in view seems to be the prevention of warping, I am inclined to believe that his trouble lies not as much in the immersing as in the uneven heating of the die. I had a number of gang dies given to me some years ago, the dimensions of which were ½-inch × 2½ × 9 inches and by heating them in a muffler furnace and immersing diagonally across the corners I had no difficulty in keeping them straight. It is hardly necessary to state that the die should not be moved about broadside to the water, but with the point of the least resistance.

Mr. Shailor's method of drawing the temper of the die also seems to me to be a strange one. The method which I have found to be the safest is the placing of the die over a Bunsen burner on a stiff piece of sheet iron. The idea of drawing the temper and the reason for it is the gradual reduction of the brittleness through the entire die, starting at the base and traveling upward toward the point of application, which in a blanking die is the cutting edge, and in a forming die the forming surface. If, therefore, the forming die in question is placed on hot coals or near the fire, the heat can attack the frail portion of the die and draw the temper out of it before even the strain in the die is relieved, which may result in cracks running along the sharp edge of the thread in the form.

I cannot join my brother toolmaker in his objection to the use of oily waste while drawing the temper and I still cling to the time-honored custom. This may be a matter of training or opinion, or both; but I am convinced that the color on the die after wiping with oily waste is the true color and the color unwiped the false. I have noticed that a piece of steel during the drawing process does not show any color for some time if untouched and then changes color very rapidly, while an occasional touch with an oily substance shows the changes of the various degrees very plainly.

To close my criticism of Mr. Shailor's methods I would like to warn against the overdoing of the practice of trying a forming die with sharp corners while soft, as I nearly spoiled a die at one time by doing this. Frank Greiner.

New York, N. Y.

A REVERSIBLE FRICTION RATCHET.

Editor Machinery:

In constructing a large single-acting press, a short time ago, we were called upon to furnish a roller feed that would be reversible so that stock could be fed either from or toward the operator. The ratchet by which this was accomplished was not of new design, as it has been used on some presses for many years to my knowledge, but I have never seen it described. Its simplicity and the ease with which it can be reversed recommend it for many places in machine tool construction where a noiseless reversible ratchet feed is required. The ratchet is mounted on one of the feed roll shafts and is operated in the usual way from a crank on the main shaft of the press. The connecting rod from this crank is connected with the upper end of the ratchet arm *A*. This arm is fastened to the ratchet casing *B* and imparts to it its oscillating motion. This motion is transmitted to the roll shaft by a set of friction rolls and the hardened steel block *C*, to which the shaft is keyed. As the casing is oscillated in one direction or the other one set of the steel rollers, *E*, *E* or *F*, *F*, becomes bound between the block and the casing and causes them to revolve together. As soon as the direction of rotation of the casing is reversed the rolls are freed from their contact and the casing is moved backward independent of the block. As will be seen by the sketches, one set of the rollers only is employed when feeding in a given direction. In order to hold the other set inoperative a cover plate *D* is placed over the face of the ratchet block and fastened to it by two bolts, *G*, *G*. At the points where these bolts pass through the plate are two grooves which allow the plate to turn around the shaft through an angle of about 20 degrees. This plate is fitted with six retaining pins *H*, *H*, *H*. When the plate is moved so that the bolts are at one side of the slot these pins hold one set of rollers out of action as shown, in Fig. 2, where rollers *E*, *E* are free to move the block and the set *F*, *F* are held out of action. In this position the ratchet will feed the roll-shaft in the direction indicated by the arrow. Wishing to reverse the direction of rotation of the shaft, it is only necessary to loosen the bolts *G*, *G*, and turn the cover plate as far as the slots will allow. This causes the retaining pins to throw the set of rolls *E*, *E* out of action and to release the set *F*, *F* as illustrated in Fig. 3. The shaft is then rotated in the opposite direction. The springs shown back of the rolls insure the active set being always in contact with the casing so that there is practically no lost motion.

New York, N. Y. George Henry.

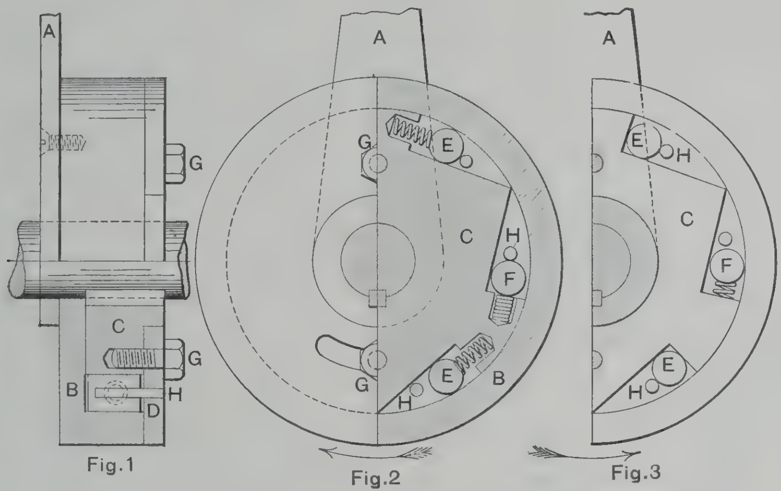


Fig.1 Fig.2 Fig.3

Reversible Friction Ratchet.

CENTERING WORK ON THE FACEPLATE.

Editor Machinery:

Most mechanics appreciate the difficulty of turning pieces true with a tapped hole by using a threaded arbor. Owing to this difficulty we have often to resort to other expedients. We had a large number of castings, such as are shown in Fig. 1, which were finished all over, and it was necessary that the thread be true with the exterior surface and at right angles with the face. Not having a jaw chuck in the shop that was accurate enough for this purpose, we proceeded to machine them in the following manner: The castings were first drilled to the tapping size and were accurately turned upon a common arbor in the usual way. We then bolted to the faceplate the three blocks, *A*, *A*, *A*, which were so located that they could be bored out to the diameter of the flange on the casting. These were bored slightly tapering so that the finished piece could be easily removed. Three clamps were fitted to these blocks and one of them was slotted as shown at *C* so that it could be withdrawn under the bolt head and the casting removed and replaced without taking out the other two bolts. The holes in the castings were screw-cut as nearly to size as possible and then completed with a sizing tap, which was supported upon the tailstock center.

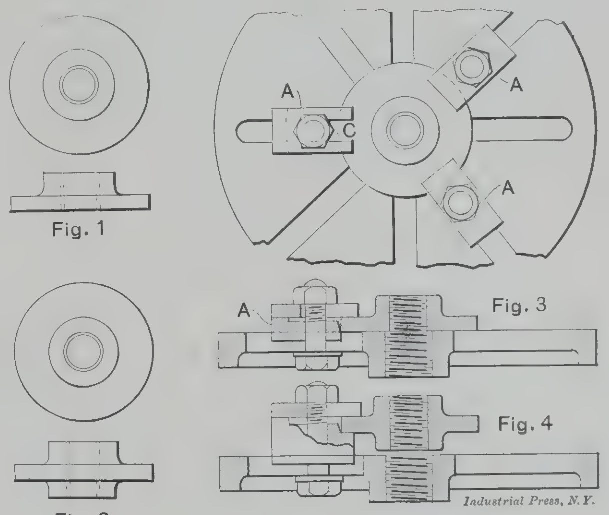


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Faceplate Centering Pieces.

Occasionally the castings had a hub on both sides, as shown in Fig. 2, and in this case the locating pieces were made with a shoulder as is illustrated in Fig. 4. Francis W. Shaw.

Birmingham, England.

TESTS WITH FLAKE GRAPHITE.

Editor Machinery:

We have read with much interest your editorial in Machinery for December on the subject of "Graphite vs. Friction," and we have thought that you might be pleased to receive a contribution on this subject, especially as this will cover a test made by Professor W. F. M. Goss, of Purdue University.

The experiment consisted in an attempt to wear down brasses by the use of dry graphite alone as a lubricant. The experiment was made in connection with a special testing machine and the manner of applying the graphite was so arranged that the journal was made to revolve in a bath of graphite. The journal was fresh from the lathe where it had been well turned and slightly polished. The brasses were smooth-bored and quite free from imperfection. Judged by the standard of a railroad shop, both the journal and brasses were "ready to run."

With a new journal and brass, it would be expected that if run in oil, they would at first heat more or less and that some time would be required to work the brass down to a perfect fit on the journal. The outline of the test provided that no oil should be used but that an attempt be made to wear the brass down by use of dry flake graphite alone. Therefore no oil was used at any time during the test. In carrying out the experiment, as much pressure was put on the brasses as the machine would carry and the journal was run as fast as was practicable without too much heating and continued as long as the belt would carry the load. The running was attended with a great deal of noise, the squeak being similar to that which proceeds from a dry axle-box. The results showed that the frictional resistance was at all times very high; values of 16 per cent. or more being characteristic of unlubricated surfaces, as, for example, of a brake-shoe upon a car-wheel. As the tests proceeded, the frictional action improved; the values in coefficients gradually declining.

The tests were very interesting and we only regret that space will not permit us to furnish your readers with a full summary of results. We will only say that when the machine was taken apart and the bearing surfaces carefully examined, the journal was found to be without a scratch and to have a high polish. The upper brass was found to have about 35 per cent. of its surface in bearing. A close examination of the brass revealed the fact that the surface of contact had not been secured as a result of wear in the brass as is usually the case, but that graphite had implanted itself in the surface of the metal and where the surface of the brass was more remote from that of the journal and had built up, as it were, a graphite-bearing surface. This built-up surface possesses a bright, metallic lustre, is well burnished and while compacted as by heavy pressure and quite capable of easily supporting a heavy load, it would flake off under the action of a tool; the flakes retaining the shape of the bearing after removal. When the brass was in actual contact with the journal, it was but little worn.

In another test, when the machine was opened, the bearing space amounted to altogether 45 per cent. of the area of the brass and was composed almost entirely of an overlaying mass of compact graphite, leaving the entire central portion of the brass out of bearing. Within this central portion there was more or less graphite but much of it was imperfectly compacted and it fell away when the brass was removed. Parts of its surface were bright and gave evidence of having at some time had contact with the journal, but just previous to its removal it did not have contact.

The conclusion to be drawn from the set of experiments is a two-fold one. The first is that the brass cannot be worn to a fit on its journal while lubricated by graphite alone. Not only does the graphite tend to fill in the brass where it does not touch the journal, but it acually builds up a new shell within the brass and by so doing relieves the brass itself from much of the contact which it would otherwise have.

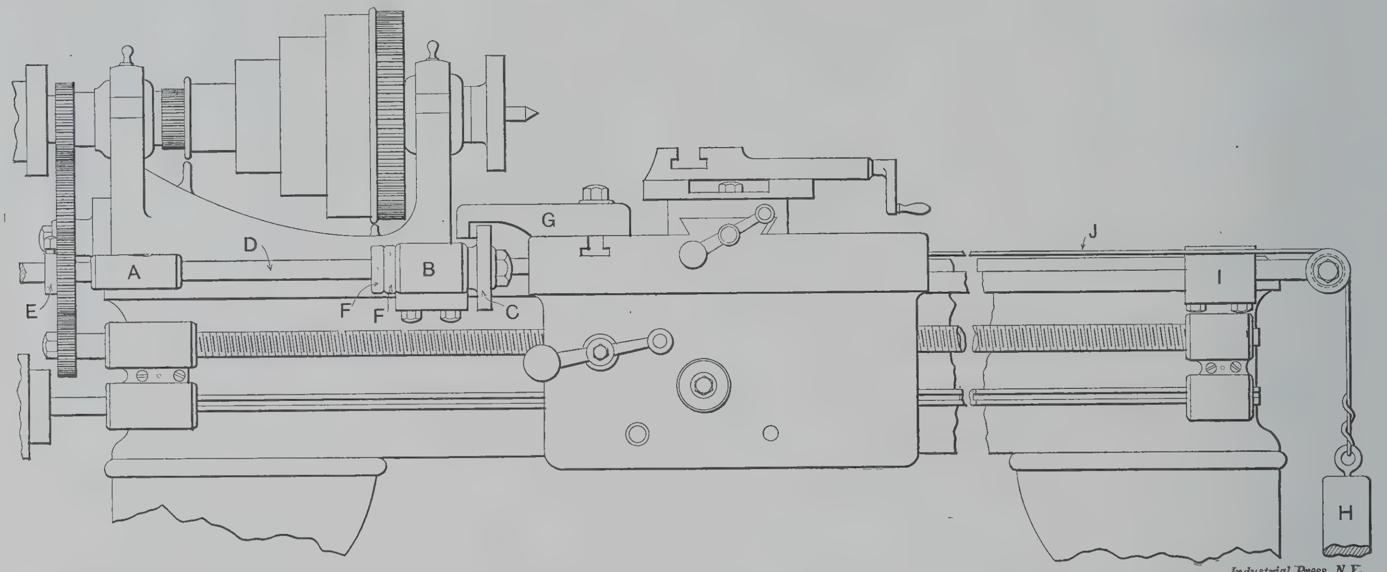
The second fact developed is to the effect that neither journal nor brass is easily cut or injured in the presence of flake graphite. The tests showed that with no other lubrication than dry flake graphite, the journal and brass might be run together for hours at a time, keeping up to a high temperature, and that this might be done repeatedly and yet the rubbing surfaces of the bearing remain unscored.

JOSEPH DIXON CRUCIBLE CO.
Jersey City, N. J. Per Secretary.

ATTACHMENT FOR RELIEVING FORMED CUTTERS.

Editor MACHINERY:

In making formed face-cutters, such as are used in the screw machine to operate on the end of the bar, it is desirable to so shape the cutting teeth that they can be ground without changing their form. To accomplish this I have employed the relieving attachment here illustrated, which has given very good satisfaction and has the advantages of being simple in construction and easily applied to any style of lathe. As it is operated by the change gears of the lathe it can easily be geared up to relieve cutters having any number of teeth. The lathe to which it is attached should be of rigid design and fitted with a compound rest. The screw cutting gears should not be finer than 14 diametral pitch. The details of this attachment as applied to the lathe will be clearly seen by referring to Fig. 1. The bracket *A* is bolted onto the side of the headstock and carries the cam shaft *D*. The other end of this shaft is carried in the bracket *B* which slides along one of the ways of the lathe and is provided with a clamping device by means of which it can be fastened at any desired position along the lathe bed. The shaft in this bearing is 1¼ inch in diameter while for the remainder of its length, except in the thrust collars, it is 1 inch in diameter. This shaft is splined from the bearing *A* to its outer end and is cut about 18 inches longer than is necessary when it occupies the position shown in the figure, which makes allowance for moving the bearing *B*.



Industrial Press, N.Y.

Fig. 1. Lathe arranged for Relieving Face-cutters.

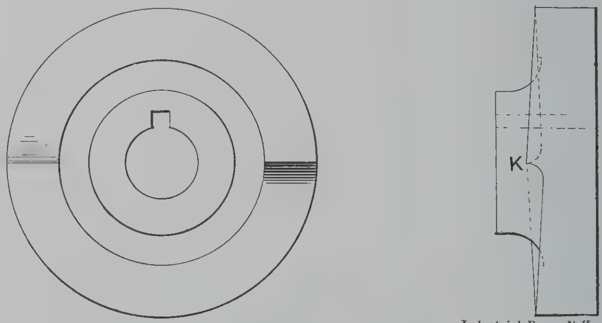


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Fig. 2 Two-step Cam for use in Relieving Face-cutters.

The gear *E* is made of such a diameter as to mesh with the gear on the lead screw and these two gears are always employed when using this attachment. The hub of this gear gives it more bearing surface on the cam shaft; a key is fitted to slide with it along this shaft while the setscrew holds it in position when the cam has been set.

Upon the inner end of the cam shaft is placed the face cam *C* which serves to impart the backward and forward motion to the lathe carriage. In making this attachment it is best to provide three of these cams having one, two, and three steps respectively, as cutters having any number of teeth can then be backed off with much simpler combinations of change gears than when but one of the cams is provided. A detail of one of these cams, one having two steps, is shown in Fig. 2. They are made of tool steel, hardened, with a ⅞-inch hole and a key-way to fit the end of the shaft *D*. When no cam cutter is at hand I have found the best way to make them is to mill—with a 5-16 inch convex cutter—one, two or three, as the case may be, radial slots in the face of the cam. Then gear up the lathe to the required pitch and work the stock off by hand. The cam finger *G* is securely fastened to the lathe carriage and its point is always in contact with the face of the cam so that as the cam revolves it pulls the lathe carriage forward until the finger reaches the top of the step *K* when it is drawn back by the action of the weight *H* which is attached to the carriage by the wire *J*. In pulling the carriage forward the thrust of the cam is taken up by the two thrust washers *F F* which are fitted to the cam shaft by a 1 ¼-inch fine thread.

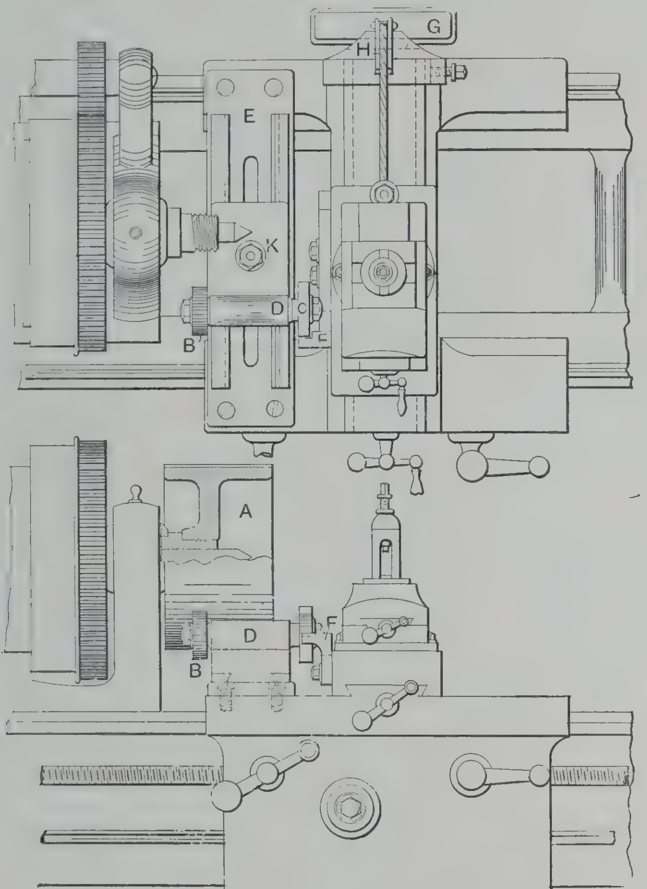

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Fig. 3. Lathe arranged for relieving Formed Milling Cutters.

The lathe with which this attachment is used is so constructed that all of the gears in the apron can be released, leaving the carriage at liberty to oscillate freely; should it be placed on a lathe that was not so constructed it would be well to remove the screws binding the carriage to the apron and thus allow the carriage to move entirely independently. The face cutter being relieved is held in a split collet in the spindle of the lathe or strapped against the head center and held in a steady rest. The forming tool is fed forward in the compound rest which is set at right angles with the cross-slide.

For relieving formed milling cutters, worm wheel hobs, etc., I have made use of the arrangement shown in Fig. 3. This is applicable to any good rigid lathe that has a compound rest and is so constructed that the cross-slide screw can be disconnected from the carriage. A lathe having a taper attachment is usually admirably adapted for this purpose, as it is usually arranged so that the cross feed screw is disconnected by simply releasing a nut or two. The cast iron gear *A* screws onto the spindle of the lathe and is cut the same pitch as the change gears so that these gears may be used in gearing the attachment to relieve cutters having any number of teeth. The gear that I used for this purpose was 10 inches pitch diameter of 14 diametral pitch, having 140 teeth. It is shown in detail in Fig. 4. Through the web of this gear is cut an elongated slot for the insertion of the tail of the driving dog, while a sliding clamp is used to prevent back lash. One end of the shaft which is carried in bearing *D*, Fig. 3, is made exactly like the end of the lead screw of the lathe so that any of the change gears can be used for the gear *B*. On the other end of this shaft is the hardened tool steel cam *C* which imparts the oscillating motion to the carriage. Should the lathe not have a very great assortment of change gears it would be well to provide several of these cams having one, two, three, and four steps, respectively, so that cutters having any number of teeth can be relieved. The bearing *D* carrying the crank shaft is dovetailed to a cross slide *E* which, in turn, is bolted to the lathe carriage. This allows the bearing to be moved in or out to accommodate the different sizes of change gears that may be used for the gear *B*, while a bolt *K*, working in a slot through *E*, serves to clamp *D* firmly when it has been placed in position. Fastened to the cross slide carriage is the cam finger *F* which transmits the motion of the cam to the carriage. The bolts by which this finger is fastened pass through a slot so that the finger may be moved in or out to obtain adjustment. A wire cord, fastened to the cross slide carriage, passes over the pulley *H* and connects to the weight *G*. This keeps the cam finger in contact with the cam, and the tool consequently follows the oscillating motion which it imparts. One very desirable feature of this attachment is that the feed screw of the lathe can be used in connection with it. This makes it applicable to backing off worm wheel hobs and relieving taps. The work in most cases is held on an arbor between the centers, with a dog acting as the driver. In relieving mills and hobs it is best to use an arbor having a nut and shoulder to hold the work securely, as an arbor that is merely pressed into the work is liable to slip and consequently destroy the cutter. Jos. M. Stabel.

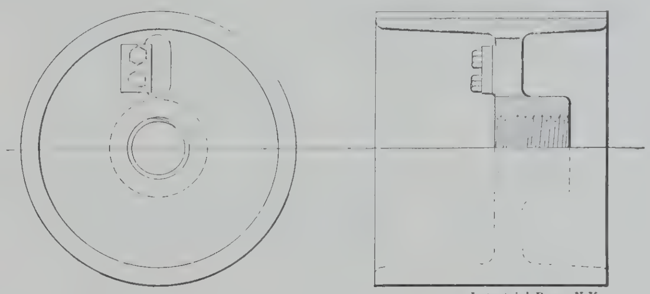
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Fig. 4. Gear for Driving Cam in relieving Formed Cutters.

New Haven, Conn.

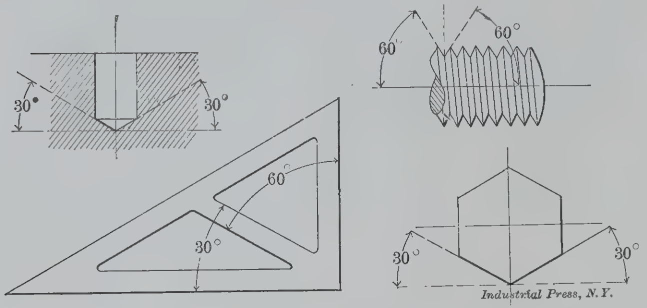
* * *

M. Quesnel, a French engineer, is alleged to have discovered alloys for aluminum that impart to this widely advertised metal most astonishing qualities. By varying the amount of his alloy from one part in 12 to one part in 240 he obtains aluminum compounds varying in tensile strength from 29,000 to 58,000 pounds per square inch. These have different characteristics so that some may be chased, soldered, brazed, forged, rolled into plates and leaves or drawn into wire, depending on the amount of alloy. It can be made soft like pure aluminum or stiff and rigid like steel and possessed of nearly the same strength and weighing only about one-third as much. So much has been promised for aluminum and its alloys that we shall await the advent of this new wonder with some distrust until its claims to recognition are based on actual demonstration.

CONTRIBUTED NOTES AND SHOP KINKS.

A HANDY TRIANGLE.

A. T. S. sends us the sketch of a triangle that he made for his own use and found to be a very handy tool. It is a 30 by 60 degree triangle, having internal angles of the same degrees, but opposite to the external ones. With a triangle of this form hexagons, screw heads, the bottom of drilled holes, etc. can be easily and quickly drawn, as it is not necessary to reverse or turn over the triangle, but merely slide it along. Every draftsman doing detail work would find this tool a valuable acquisition to his kit.



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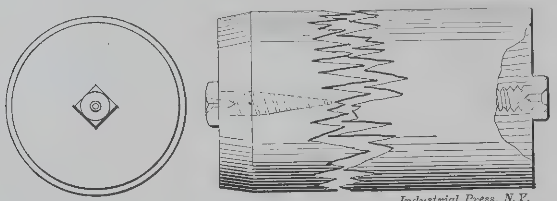
A SPECIAL ARBOR.

Regarding special arbors, D. M. says: When a job requires a special arbor, of from 3 to 6 inches in diameter, it is quite customary to drive two cast iron collars onto a smaller arbor, placing them at the proper distance to accommodate the particular job in hand. These collars are then turned to fit the pieces with which they are to be used. As a handier scheme than this I have used a wooden arbor very successfully when the turning was not very heavy. This is made of hard wood with very little, if any, taper except for about half an inch at the end where it first enters the hole. A ¾-inch lag or coach screw is screwed into each end of the block and these are centered in the drill press. The block is then turned to size on the centers. This arbor should be used very soon after turning, before the wood has time to shrink.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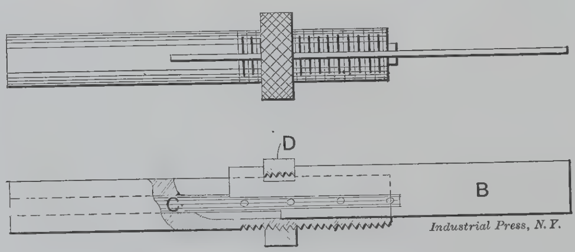
AN ADJUSTABLE FINGER FOR USE ON THE GRINDER.

Most any one who has run a grinder to any extent has noticed the lack of fine adjustment on the stop finger when backing off or grinding the lands of reamers and cutters. With the ordinary finger the adjustment is made by tapping it up or down, an operation which is very uncertain, besides consuming considerable time. In order to provide for fine adjustment, C. P. Thiel, Lawrence, Mass., has made the finger which is shown in the accompanying sketch, and reports that he has found it very satisfactory. The shank of this finger was made of suitable size to fit in the holder provided for the old finger and was cut, for part of its length, with an 18 pitch thread. Over the threaded end is fitted the knurled nut D, which is used to feed the blade up and down. Through the center of the shank is drilled a 3-16-inch hole, while in the threaded end is cut a narrow slot that extends about one-half the length of the shank but opens only on one side. A piece of 3-16-inch wire, C, is split at one end and fitted with the blade B, which has a notch in its lower end for receiving the adjusting nut D. It will be clearly seen from the sketch how the parts are assembled and operated. Different blades with their stems can be made for different classes of work and used with the same shank.



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STEEL LEGS FOR THE TOOL BOX.

As is well known it is very unhandy to have the tool box set on the bench, owing to the fact that if anything be lying in front of it the bottom drawer cannot be opened readily. So it is customary to place the box on blocks that raise it about four inches above the level of the bench. As an improvement upon the use of blocks, R. A. Lachmann, Chicago, has fitted his tool box with steel legs, as illustrated in the sketch. In the first place four pieces of machine steel ¼x¾-inch, were drilled and tapped as shown in Fig. 2, and one of these was fastened to each lower corner of the box. These plates were let in flush with the sides of the box and secured with two wood screws. The legs were made from 3-16x¾-inch steel pieces as shown in Fig. 3 and were bolted to the corner plates by two ¼-inch tap bolts.

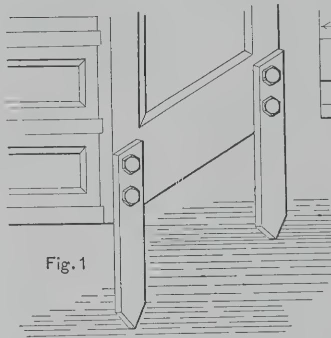
Fig. 1

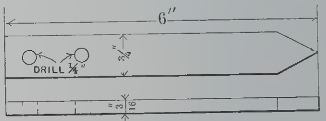

Fig. 3

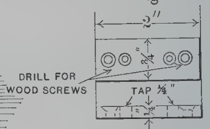

Fig. 2

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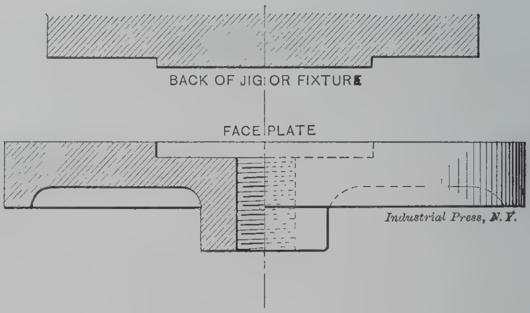
LOCATING WORK ON THE FACEPLATE.

Referring to the article, by Corneil Ridderhof, in January MACHINERY, in which he advocates drilling dowel pin holes in the faceplate, Geo. Henry writes: The object of the dowel pins is to locate a jig or fixture so that its center will be located in line with the lathe centers. I have found a very convenient way of doing this is to turn a boss on the back of the jig so that the center of the boss will coincide with the center of the jig, and to bore a corresponding recess in the faceplate. Any number of jigs may be made to fit this recess and when putting a jig in place no time is lost in hunting for dowel pin holes. By employing this method the appearance of the faceplate is in no way injured.



Industrial Press, N.Y.

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An English novelty in sketch books for engineers and draftsmen, is a blank book with thin semi-transparent leaves for perspective drawings. A number of loose sheets are provided, with correctly drawn perspective lines, which are slipped under the blank page upon which the drawing is to be made. The perspective lines on the loose sheet show through in the same manner as the ruled lines often employed when writing on unruled paper. It is said that with this book true perspectives can be drawn without the use of a ruler or the determination of the vanishing points.

APPRENTICE SYSTEM OF THE BROWN & SHARPE MFG. CO.

At the works of the Brown & Sharpe Mfg. Co., Providence, R. I., a system of apprenticeship is in operation which has been found mutually beneficial to the firm and to its apprentices, for, while it obtains the results of their labor, they in turn are allowed the use of valuable machines and tools, at the same time receiving proper instruction in the modern methods of machine shop practice. The system, while being to a certain extent instructive, is not to be classed as a school, neither is it considered as such. The purpose is to make good machinists of the boys. Since the first apprentice was received by the firm 45 years ago over 300 have served an apprenticeship, a large percentage of whom are to-day engaged in directing or overseeing, either at Brown & Sharpe's or in other manufacturing establishments. The following description of the system was given by Mr. Mitchell Dawes, at a meeting of the New England Association of Teachers of Metal Work.

Applicants for admission to apprenticeship must be from 16 to 18 years of age, physically sound and have received an education equivalent at least to that required for graduation from the public grammar schools of the City of Providence. Personal interviews are preferred, but this not occurring, a photograph is required, with particulars as to health, sight, hearing, weight, and a statement as to the studies the boy has had and his advancement in each. If the applicant is found to possess the necessary qualifications, his name is registered and due notice given him when he will be required to commence work. The first eight weeks of service constitute a term of trial, during which both parties have an opportunity to determine whether they are agreed to continue the apprenticeship for the full term. The eight weeks above mentioned are counted as part of the first year's service and are paid for at the rate for that year. If everything is satisfactory at the end of this trial, an agreement is drawn up and entered into by Brown & Sharpe, the boy, and a parent or guardian, stating that, as the boy desires to become an apprentice to Brown & Sharpe for the purpose of learning the art or trade of machinist, Brown & Sharpe take him in their employ, and the boy agrees to become the apprentice of Brown & Sharpe in the machinist's art or trade, and to faithfully conform to their rules and terms of apprenticeship. The parent or guardian, in consideration of the covenants on the part of Brown & Sharpe, pay them as compensation for receiving the boy the sum of fifty dollars. Brown & Sharpe further agree, in case the boy shall serve the full term of apprenticeship and comply with the provisions of the terms of apprenticeship, to pay him at the termination of said term, in consideration of such faithful service, the sum of one hundred and fifty dollars. The term of service is four years, each year to consist of two hundred and ninety-five working days of ten hours each. The remaining working days in each year are allowed for recreation, as the Company may direct. Graduates of the Providence Manual Training School, well recommended by the principal, may have their term of apprenticeship shortened at the discretion of the Company.

Apprentices are required to perform their duties with punctuality, diligence and fidelity, and to conform to the rules and regulations which are or may be adopted for the government of the shops.

They are not allowed to use tobacco in the shop during working hours, and boys who smoke cigarettes are not accepted.

They make up lost time at the expiration of each year, at the rate of wages paid during said year; and no year of service commences until the apprentice has fully made up all time lost in the preceding year.

The Company reserves the right, whenever the state of business demands it, to shorten the hours of labor, or whenever for any reason it should stop the works, to suspend apprentices wholly or in part; and the making up of time so lost is at the discretion of the Company. The Company also reserves the right, in its sole discretion, to terminate its agreement with any apprentice; also to discharge him from its employment for non-conformity with its rules and regulations, want of industry or capacity, indifference to his duties or improper conduct within or without the shops.

Apprentices are paid for each hour of actual service, not including time allowed for recreation or time when work is suspended, the following wages: For the first year, 6 cents; for the second year, 8 cents; for the third year, 10 cents; and for the fourth year, 14 cents. If the company terminates the apprenticeship during the time of trial, it pays at the rate of six cents per hour for the time worked. Wages are paid on the regular pay days of the Company, as they may be established from time to time. The Company engages to faithfully instruct the apprentice in the machinist's art and trade, in their shops, during the term of apprenticeship.

When a boy begins work he is loaned a set of tools, consisting of a hammer, wrench, rules, calipers, dividers, etc., and a one-inch micrometer caliper. If he is accepted at the end of his trial term, these tools are sold to him and his name is marked on each. He is put under the personal supervision of a sub-foreman, who starts him on some of the simpler forms of work, such as centering and straightening, etc., and shortly after, he is given lathe work, roughing out mostly, always under the supervision of this foreman, and working from drawings almost from the start. As he learns he is advanced, according to his capability. During his apprenticeship, if the boy continues capable, he will probably have work on lathes, drill presses, milling machines, screw cutting, double tool lathes, scraping, planing, spindle work, erecting, assembling and general shop work, with work in the grinding and gear cutting departments, as the English method of making specialists is not followed at these works.

It should also be mentioned that a handbook for apprentice machinists is given them during their first year. This book is published by the Company, and was gotten up for this purpose. The rules, kinks and advice contained therein have become of much use to the boys. Should a boy come from a distance and have to board, a good place is selected for him, if requested, and he can go there at once on his arrival. This class of non-residents are closely looked after during their apprenticeship, particularly as to their habits, punctuality, and health; and they are put in the way of receiving proper medical attendance if ill at any time.

There are now 118 boys learning the machinist's trade at the works, and they are taking about forty boys a year. A large percentage of these are retained, the remainder being rejected or leaving of their own accord. Of those who complete their apprenticeship, a few are remarkably well qualified, over three quarters are good machinists, the rest are only passable.

Apprentices are allowed to have piece work or job work from time to time, thus earning extra compensation, and bringing into play oftentimes dormant faculties which, when once aroused, are ever after successfully made use of to their advantage. The boys of New England are naturally in the majority, though there are some from the Middle and Southern States.

An excellent library is maintained at the Company's expense, free for the use of all. It contains works on mechanics, history, travel, as well as a good class of autobiographies and works of fiction. It is well patronized. The boys are encouraged to attend the R. I. School of Design and the evening public schools, paying particular attention to drafting and mathematics. An incidental feature of a boy's apprenticeship at these works is an organization of the boys themselves, called the B. & S. Apprentice Association. This club furnishes a valuable means of cultivating a good spirit among them, as being at the works for a common purpose. They meet once a fortnight. The meetings last one hour, and this hour is allowed them. They discuss mechanical subjects, engage in debates, or are addressed by competent speakers selected for them by the Company. One feature in connection with this Association worthy of notice is their "question box." Members are allowed to deposit therein any written question pertaining to the trade they are learning. These questions are given to a Question Committee, which is appointed semi-annually; the subjects are investigated, and answers announced at the following meeting, and then turned over to the librarian, who keeps a record of both questions and answers for future reference.

From year to year, as the boys express an interest in what is going on in other shops, the fourth-year apprentices have been allowed to visit other establishments. Last year they visited the Prentice Bros. and F. E. Reed shops, and the Knowles Loom Works at Worcester, Mass., and reports of what they saw were given to the "stay-at-home" members of the Association.

The firm employs one man whose duty it is to look after the apprentices both in and out of the shops, see that they have fair treatment, proper instruction as to use of tools, settle any grievances, and also to see that on the boy's part he does not idle away his time, but puts forward his best efforts toward obtaining that which he came to learn. He encourages them to bravely bear disappointments occasioned by spoiled work, be manly, upright, neat, and specially careful, and he endeavors to impress on a boy's mind that he should get from a tool or a machine all that it is capable of standing, especially when roughing out work. They are taught that intensity of application, and concentration of purpose combined with natural qualifications, the environments notwithstanding, will surely help a young man to become a master of his chosen vocation.

In conclusion, Mr. Dawes says: The most noticeable failing about the young technical scholar who has been taught the use of tools and enters as an apprentice to the machinist's trade, is that he has no idea as to the commercial value of time, and it consequently takes a long time to teach him how to do his work in an economical manner. This is difficult, as he is imbued with the idea that he knows well how to work and use tools. Therefore, I would say that, in addition to what you now undertake, you also teach the boy how to work rapidly; and do not allow him to finish highly or spend time in polishing any part of the machine that is being constructed unless it is required by the designer or necessary for the smooth running of the machine in question. The majority of manufacturers do not buy a machine on account of its finish. Its utility is first considered, next the cost, and lastly the finish. The unnecessary finish that is often bestowed on a machine so frequently increases its cost that the probable purchaser is frequently led to select as good a working but plainer machine of another make. ,

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DOUBTFUL SOURCES OF POWER.

In a paper read before the Institution of Electrical Engineers by James Swinburne, December 4, 1902, various sources of power were discussed and their limitations pointed out. It has often been advanced that tidal power could be advantageously employed in many places where the rise is of abnormal height, but the author pointed out that calculated results were often fallacious. Take for a sample case, a tidal rise of 49.2 feet where an area of 10,764 square feet could be flooded. Into this space 529,710 cubic feet would flow twice daily, and, of course, the same amount outward, twice daily. On this basis the tidal enthusiasts figure a total equivalent fall of 196.8 feet for 529,710 cubic feet of water which would give 100 K.W. or 134 H.P. per day. But this is untrue because the average head is only 24.6 feet and this only holds at the periods of extreme high and low tides when the whole volume would have to be discharged in a few minutes. Such a system is unpractical. A system of tanks is described by which the power generated would be practically uniform, but it would provide only 10 K.W. or 13.4 H.P. and this at the periods of maximum tides. The power would be greatly decreased at neap tides.

As to "getting electricity direct from coal," the author is equally as discouraging. He says that it is the dream of the electro-chemist to devise an electrolytic cell in which the consumed electrode is carbon. But this he believes impossible. At ordinary temperatures carbon is practically inert. It forms no ions and therefore can give no electromotive force. At high temperatures oxygen, sulphur, silicon, and to some extent nitrogen, and many of the metals combine with carbon, but there is no dissociable salt of carbon formed. The carbon cell thus seems impossible.

ITEMS OF MECHANICAL INTEREST.

Thumb Screw Wrench — Reversible-jaw Chuck — Hardened Spindle with Soft Thread — Anti-friction Bearing — Key Duplicating Machine.

WRENCH FOR THUMB SCREWS.

The accompanying illustration shows a convenient form of wrench for tightening thumb-screws or for adjusting them when they are too hot to be handled. It consists of a strip of sheet steel cut and bent to the form shown, with the doubled parts riveted together and one portion cut away for the reception of the thumb-screw itself. It is easily made and will form a handy tool for the purpose for which it is intended.—*G. L. F., Zeitschrift für Werkezengmaschinen und Werkzeng.*

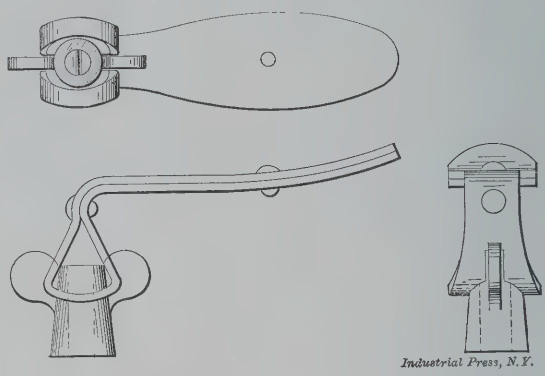
Industrial Press, N.Y.

Fig. 1. Thumb Screw Wrench.

ENGLISH REVERSIBLE-JAW CHUCK.

The idea shown in the cut of an English reversible-jaw chuck, is to mount each jaw on a little "turntable" so that it may be swiveled to any desired angle and then clamped by the bolts on each side, the bolt heads being engaged in circular T-slots which allow free circular movement. The ease with which the jaws may be reversed will appeal to almost every mechanic who might otherwise be inclined to unfavorably criticise the design. But while the reversible jaw feature is all right, it is not quite apparent what the advantage is in being able to clamp the jaws in any other but their normal positions unless it might be in holding some odd-shaped pieces that are rarely met with in lathe work. The makers of the chuck, H. W. Cowley & Co., Bolton, Eng., make a strong claim for this feature, saying that it is one not possessed by any other chuck.

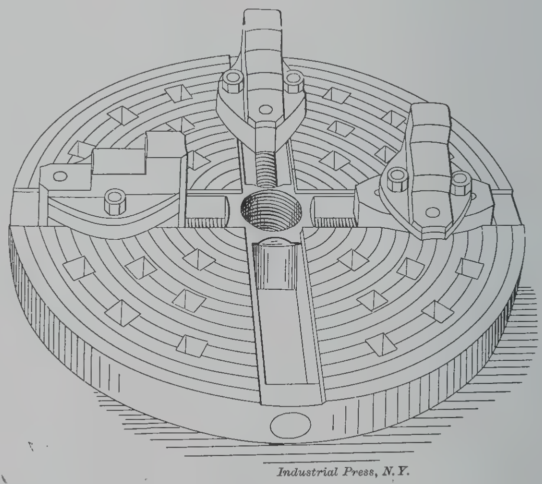
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Fig. 2. Reversible-jaw Chuck.

HARDENED LATHE SPINDLE WITH SOFT THREAD.

On the occasion of a call at the shops of the Waltham Watch Tool Co., Springfield, Mass., a few weeks ago, Mr. Van Norman called our attention to the manner in which they make bench lathe spindles hardened all over and still obtain a soft thread for the chuck. It is scarcely necessary to explain that it is highly important to have the spindle nose of a precision lathe (or any lathe for that matter) truly threaded, or that, in the ordinary course of events, if the thread is cut before the spindle is hardened, it will not run truly with the axis afterward. So about the only course of procedure left open in making a hardened tool steel spindle with nose thread integral, is to harden it leaving the nose portion soft, and then to cut the thread, since it is scarcely feasible to grind the thread after hardening, although we believe this is sometimes done.

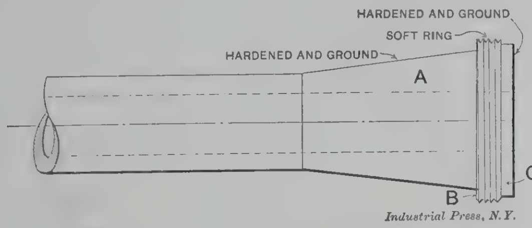


Fig. 3. Hardened Spindle with Soft Thread.

The manner in which the Van Norman bench lathe spindle is made so as to accomplish the end of getting a soft portion for threading after hardening, is shown in the cut. The spindle, which is made with taper bearings, the taper of the tail bearing being opposite to that of the head bearing, is made with a collar *C* at the end. A portion of the spindle back of this collar, is turned straight, for a short distance, for a seat. After the spindle has been hardened and ground, a soft steel collar *B* is heated and slipped over the tail end, and shrunk onto the seat next to the shoulder. The ring is then threaded for the chuck, and forms a sort of external nut, so to speak. The chuck faceplate is made with a face inside the bore, to bear against the ground face of the spindle, *C*.

GERMAN INSERTED CUTTER LATHE AND PLANER TOOL.

"Of the making of books there is no end," might with equal appropriateness be applied to inserted cutter lathe and planer tools. A German device in this line, which is said to be new, is made by C. Scharenberg, Berlin, Germany, and is shown in two styles in the cut. The locking pin *A*, is made with a squared head at each end and an eccentric groove in the middle. This pin is, of course, located in the holder so that when turned to a certain position the eccentric groove allows the cutter to be freely inserted. Then turning the pin locks the cutter firmly in place, the movement being in the direction of the pressure on the tool which thus has a tendency to increase the "bite" the heavier the cut. The locking pins for some styles of holders, are also made with only one squared head, the other head being made flush with the side of the holder for work having shoulders.

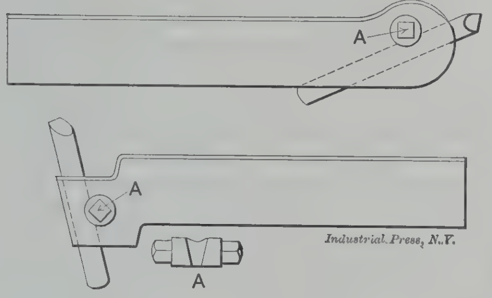


Fig. 4. German Lathe and Planer Tool with Inserted Cutters.

NOVEL ELECTRIC "STAB" SWITCH.

One of the difficulties of handling electric currents of several thousand volts tension is the arcing at the switches. In fact it is impossible to break a high tension current with an ordinary knife blade switch without an electrical display of an appalling and dangerous nature. To overcome the arcing of high tension currents, oil switches have been developed in which the electrodes are submerged in oil which extinguishes the arc when the switch is opened. A recent improvement in switches for moderately high voltages, is known as the "stab" switch. It consists of a thick fiber tube suitably secured to the marble switchboard in a horizontal position, the greater portion of the tube projecting from the back side of the board. The terminals are at opposite ends of the tube, being designated in the cut as *D* and *D'*. The switch is made in the form of a dagger, the tube forming its sheath. When the dagger is in the sheath the current is "on," and when it is withdrawn the current is broken. To smother and extinguish the arc between the terminals a marble ball *B* is provided which falls down from the pocket *C*. When the dagger is pushed back into place to close the circuit the ball is pushed up into its pocket. This switch is said to work satisfactorily up to 6,000 volts.

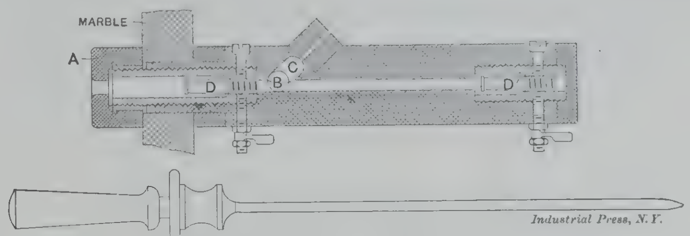


Fig. 5. New Electric "Stab" Switch.

NEW SYSTEM OF AUTOMATICALLY OILING PILLOW BLOCKS.

This oiler consists of a wooden friction roller mounted upon a removable lever which, together with the roller, can be readily removed without the aid of tools, even while the journal is in motion. The contact of the roller with the bottom of the journal is insured by the counterweight at the other end of the lever, the whole being carried on a knife edge set close to the roller and resting on the bottom of the box. The device is placed in a cavity cast in the side of the box, and which is closed by a cap at the top.

The operation is at once apparent. The roller runs in the oil placed in the bottom of the box to the depth of from 1 inch to 1½ inches, and being turned by its contact with the journal carries the oil up with it to accomplish the lubrication. The advantages claimed for this new application of an old principle are that oil is delivered in ample abundance to the journal, that the lubrication is constant regardless of the level of the oil and that the roller does not agitate the oil so as to cause it to become oxidized, but runs in it smoothly and quietly.—*G. L. F.; L'Echo des Mines et de la Metallurgie.*

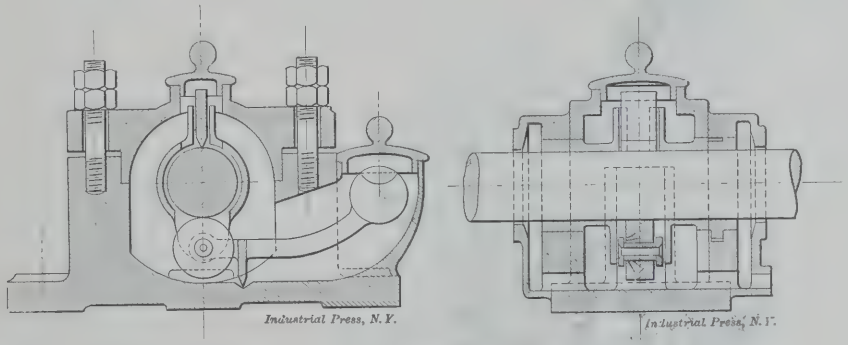


Fig. 6. Automatic Pillow Block Oiling Device.

A NEW ANTI-FRICTION BEARING.

It is a well-known principle in mechanics that the friction of a shaft journal is in direct proportion to its diameter, the smaller the diameter the less the frictional resistance to rotation. But there is a practical limit below which it is not possible to reduce the diameter of a shaft for any given load for the simple reason that it would lack strength and rigidity to support the load. For this reason a pivot is often used as an anti-friction journal in light machinery, especially in timepieces. But the use of the pivot for heavy work, is barred by lack of both strength and bearing surface. To lengthen a cylindrical journal in order to give a small shaft sufficient area to support a given load, would make a long, slim piece possessing little rigidity and one that, as ordinarily supported following the usual plan of construction, would be entirely unpractical. But it appears that there is the possibility of using extremely long, slim journals for rotating parts if the internal member or shaft is held stationary and under considerable tension.

The *American Manufacturer*, of recent date, contains a translation of an article appearing in *La Machine*, which describes the invention of a German, H. Ganswindt, for substituting a plain bearing for ball and roller bearings where it is desirable to reduce the frictional resistance to a minimum. The idea is to use a crucible steel wire stretched between supports for the wheel or other rotating member to turn upon,

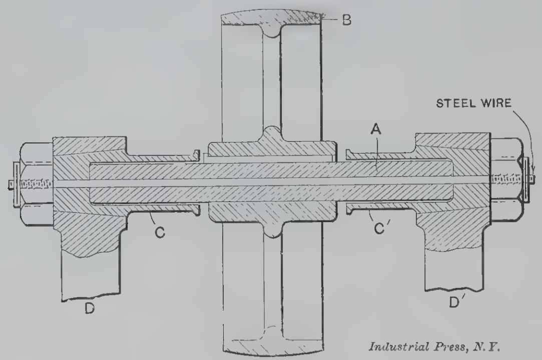


Fig. 7. Anti-friction Bearing of German Design.

the wire, of course, passing through the exact center of the hub the same as if it were an ordinary journal. Such a journal derives its strength from the fact that to fail it must be cut by shearing action, its tension preventing bending or twisting action. Crucible steel, especially hard-drawn piano wire, is very tough and meets shearing stress with great resistance. Ample bearing surface is provided by the length which may be whatever required. The accompanying illustration shows the typical construction for a pulley. The steel wire *A* is stretched between the rigid supports *D D′*. The long hub of the pulley is surrounded at the ends by cupped pieces *C C′* which are for the purpose of retaining the pulley in place should the wire break. Whether this precaution is made necessary by frequent breakages of the wire, we are not informed, but, of course, it is a reasonable safeguard.

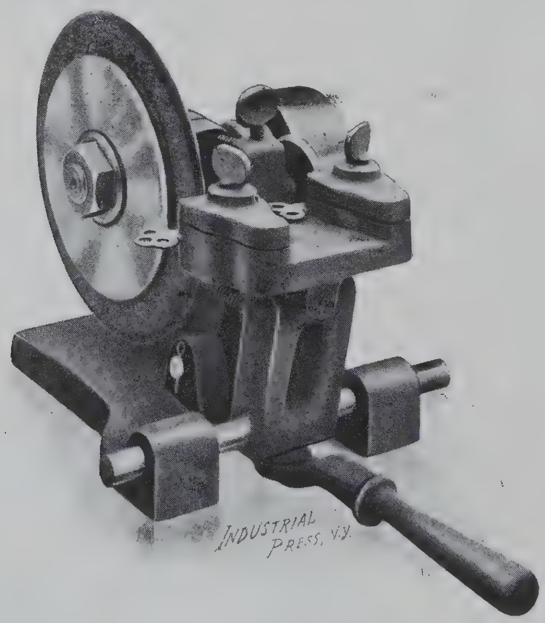


Fig. 8. Key Duplicating Machine.

Tests have shown that a wire .016 inch in diameter is of ample diameter to support a pulley weighing 200 pounds, the length of the bearing being, of course, proportioned to this weight. Thus mounted, a 200-pound pulley was given an initial velocity of 120 turns per minute, and it continued to run longer than when supported on the best ball bearings. It should be understood that no lubrication whatever was used with the stretched wire bearing in this case while the ball bearings were lubricated. Where the nature of the machine is such that motion from a rotating shaft need not be transmitted beyond the journals, it would appear that in some special cases this form of bearing might be superior to ball bearings, especially where vibration is considerable.

A KEY DUPLICATING MACHINE.

One of the tasks most frequently encountered by the locksmith is the duplication of flat or corrugated keys of the Yale and Corbin types. This has heretofore been a case of "cut and try," employing as tools the vise and file. As this is a comparatively slow and arduous task an ingenious locksmith has devised a machine by which keys may be duplicated by the use of the emery grinding wheel. One of these machines is shown in the accompanying cut. This is arranged to be driven by a one inch leather belt but for small shops, where power is lacking, a hand driving attachment is supplied. As will be seen in Fig. 9, there are two small clamps mounted on a swinging arm which, by means of a hand lever, may be moved from right to left parallel with the spindle of the machine. The key that is to be duplicated is placed in the right hand clamp. Bearing against this key is a hardened steel disk having a V-shaped edge and adjustable so that the edge bearing against the key will be in line with the V-shaped edge of the wheel. A stiff spring keeps the key always in contact with the guiding disk. The effect of this arrangement is that as the key is passed back and forth by means of the hand lever, the guide disk, sinking into the depressions of the key, allows the wheel to grind corresponding depressions in the blank and thus the edge of the blank is cut to an exact duplication of the original key. In this way a key may be duplicated in about one minute. The machine is manufactured by the Builders' Iron Foundry, Providence, R. I.

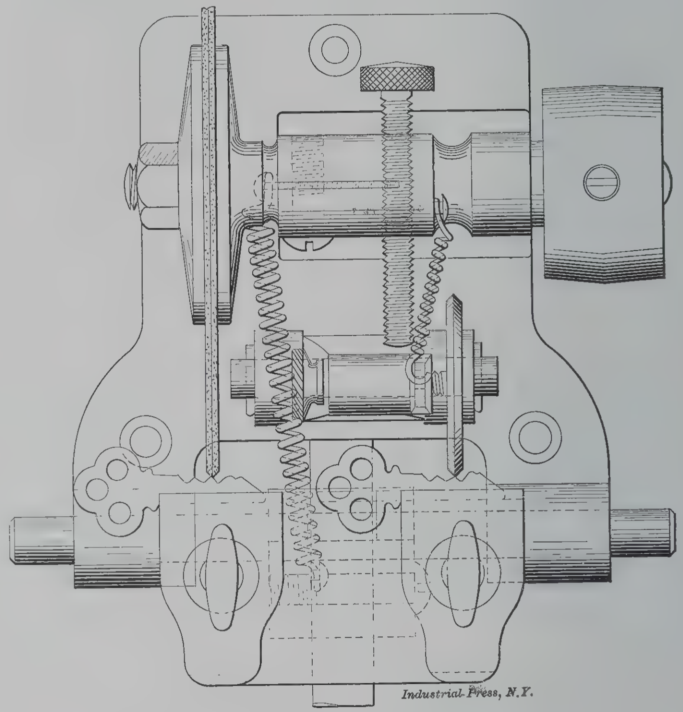


Fig. 9. Detail Plan of Key Duplicating Machine.

* * *

"The perpetual motion crank," said a patent office chief of division, "is with us always, knocking at every door of every department. His mechanism is not only to run itself, but is to supply the power for machinery of all kinds, sewing machines, clocks and everything else. When we suspect that an applicant has the perpetual motion bee in his bonnet, we ask for a working model. That is the last we hear of it. A few months ago I received a long letter from a young man in New York, saying that he was sure he had discovered perpetual motion. I treated the matter seriously and wrote him not to go to the expense of employing attorneys or making an application, but to get up a working model, and after it had run several months to let me know, and I would advise him further. Six months later I received a postal on which he had written simply the words: 'Machine wouldn't work' "—*Washington (D. C.) Star.*

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published

6. T. D. S.—Will a pump with two 4-inch pistons and a 3½-inch suction raise water 22 feet through a 6 inch suction line as well as through a 3½ inch line? There is a foot valve on both lines and the 6-inch line is connected to the pump by about 18 inches of 3½ inch pipe. If not, please explain.

A.—Theoretically the larger pipe would be the better arrangement, but owing to the difficulties of priming and those caused by entrained air and leakage around the joints it is very doubtful if the 6 inch suction could be used as successfully as the 3½-inch.

7. T. M.—If a man running a planer or shaper takes a cut ¼-inch deep with two teeth feed and then a cut ½-inch deep with one tooth feed, which takes the most power, or will the power required be the same?

A.—There would, in theory, be no difference in the power required, since the amount of metal removed would be the same in either case. Some difference, however, might occur owing to the tool being shaped so as to break up the chips more readily for one cut than the other, and this might cause a slight difference in the amount of power required, but this is as likely to occur in one case as in the other.

8. L. G. G.—Can you tell me whether the American inch is the same as the English inch; or whether there is a difference in the measurement, and in what it consists?

A.—The two are the same. The legal standard in England is a bar of bronze, 38 inches long by 1 inch square cross section, into which two gold plugs are imbedded, about 36 inches, center to center. The exact distance of 36 inches is measured between lines scribed on these plugs. Forty copies of the bar were made, which were intended to be of standard length at a temperature of 62 degrees Fahr. One of these known as Bronze No. 11, was presented to the United States Government in 1856. Through a minute error in scribing the lines, Bar No. 11 is standard length at a temperature of 61.79 degrees instead of 62 degrees. While the meter is the legalized standard in this country, the yard, taken from Bronze No. 11, is the commonly accepted standard.

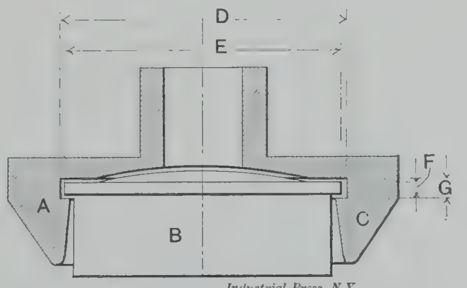
9. J. R.—In a loom a shuttle has to be thrown from side to side, a distance of about 6 feet, 200 times a minute. Some of these shuttles are lighter than the others, and these have to be thrown at higher speed to get across in time. Does the higher speed require more power? 2. I can throw a piece of wood weighing 5 pounds further than a piece of iron weighing 20 pounds, but a 4-ounce piece of iron can be thrown further than a one-ounce bag of feathers. Are these seeming contradictions caused solely by the air resistance, or does some other factor have to be considered? 3. We wish to throw a pound weight so that on delivery it will have attained a velocity of one mile per minute and will have acquired that speed in a distance of one foot. How much energy will be required, and what is the rate of acceleration?

A.—1. Not necessarily, since the friction and other resistance encountered by both the light and heavy shuttles might be the same, in which case the same energy would be required for both. But in order that the same energy be imparted to the lighter shuttle, it is necessary to deliver it at a higher velocity. Energy of a moving body increases as the square of the velocity. Thus a piece weighing one pound must be given two times the velocity of one weighing 4 pounds in order to have the same energy. 2. In the case of the piece of wood weighing 5 pounds and the iron weighing 20 pounds, the difference in distance thrown is, of course, caused by the difference in weight, but in the case of the 4-ounce piece of iron and one-ounce bag of feathers the difference is caused by the air resistance, being proportionately greater for the feathers than the iron. In a vacuum a coin and a feather fall at the same rate. 3. A pound weight projected with a velocity of one mile per minute, has a speed of 88 feet per second. A force of one pound acting on a pound weight a distance of one foot in a horizontal direction, will impart to it a velocity of practically 8 feet per second, the velocity being the same as though the weight fell freely through a distance of one foot. From the formula for falling bodies, $v = \sqrt{2gs} = \sqrt{2 x 32.2 x 1} = 8.02$ feet, in this case. Now, since with an acceleration the same as that of gravity, a velocity of 8 feet per second is imparted in a distance of one foot, to give the same body a velocity of 88 feet per second in the same distance, or one foot, the force must be $11^2 = 121$ times as great. Hence the rate of acceleration is $32.2 \times 121 = 3,896$ feet per second and the energy required would be 121 foot pounds. It should be understood that the 121 foot pounds of energy refers only to the actual weight thrown and no account is taken of the weight of the impelling apparatus.

10. A. H.—Bearing on the subject of large gas engines, treated in your last number, I have seen it stated that it would be possible to produce power at less cost for fuel with a gas engine using blast furnace gas than with the best steam engine, using coal under a boiler for generating steam. In this case the pig iron would be considered a by-product. If such a thing is possible, why should not blast furnaces be erected near our great cities, primarily for power purposes?

A.—We have heard this same plan suggested, and it certainly is a novel proposition. But we think it would not be correct to consider pig iron wholly as a by-product. It must be remembered that even if the smelting of the ore could be done for nothing, so to speak, the ore would still have to be paid for and there would also be the interest on the investment in the apparatus, the cost of attendance, etc., which would be much greater with a blast furnace and gas engine installation than with a steam plant of corresponding power. We think, moreover, that the figures by which it is calculated that the actual cost of producing the power is less with the blast furnace gas engine, have been somewhat overdrawn. From the best data available, it may be assumed roughly that 900 horse power can be realized per ton of iron produced, and that one pound of fuel is required to produce one pound of pig iron. There would thus be 900 horse power generated with an expenditure of 2,240 pounds of fuel, or about one horse power per 2.5 pounds of fuel. While this figure is very favorable to the gas engine, it is easily exceeded by large steam engines. Unquestionably the utilization of the waste gases from blast furnaces will reduce the cost of making pig iron very materially, but we do not think the production of power by this means will ever be of enough importance to warrant calling the pig iron a by-product.

11. Baer & Rempel.—Kindly submit the following to your readers: The sketch shows two cylindrical bodies, *A* and *B*, the latter having a circumferential rim *E*, which engages a circular race *D* of piece *A*. Diameter of race *D*=1 1-32-inch, width *G* of same = 1-16 inch. Diameter *E* and width *F* of the rim are 5-1000 inch smaller. Piece *B* is kept stationary, while piece *A* is fixed on a shaft and revolves at a very high speed. Both of the pieces are hardened and the difficulty lies in grinding race *D* after hardening so that rim *E* will run smoothly in it with no larger space between them than 5-1000 inch. In order that piece *B* may enter into race *D*, rim *C* is cut partly away, which is not shown in the sketch. Perhaps some of the readers of MACHINERY may be able to suggest a method of doing the job in a satisfactory manner



Industrial Press, N. Y.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

THE 2 x 26-INCH NEW MODEL TURRET LATHE.

The Pratt & Whitney Co., Hartford, Conn., have just brought out a 2 x 26-inch turret lathe which is in the same general line of construction as their ⅝ x 4½-inch and 1 x 10-inch lathes described in the December issue of MACHINERY, but with such additions as are necessary to make it suitable for the heavy work for which it is designed. The headstock, bed and pan are in one piece, as on the smaller machines, and the spindle is provided with three-step cone and double-friction back gears so that, with the three speed countershaft, eighteen spindle speeds are available.

The collet, which is used on all sizes of these machines, is so constructed that it closes without advancing or withdrawing the stock. This is a particularly useful feature when the machine is employed for "second-operation" work. The construction will be clearly seen by reference to Fig. 2. *A* is the collet proper; *B*, a spring; *C*, the closer; *D*, a cap screwed on the end of the spindle *E*; *G* is the plunger and *H* a tool steel liner. The line of contact between the collet and the nose-piece is tangent to a circle struck from the center of the spring-hole in the collet, and this contact is made positive by the spring *B*, thereby excluding dirt from the interior of the nose piece. When the plunger *G* is withdrawn, the spring *B* forces back the closer, *C*, and allows the collet to open. The liner *H*, pressed into the nose-piece, fits the closer accurately and keeps the collet in alignment with the bearings.

For use with the rod feed an auxiliary stop is provided and this, when not in use, may be swung up out of the way as shown in Fig. 1. The rod feed mechanism is of the roller type. It is adjustable for a wide range of sizes and is adapted to handle rods of most irregular section as well as rounds. It consists of two circular shells, one of which is mounted on the spindle and contains three grooved driver rollers with their axes at right angles to the spindle axis. These rollers are clamped upon the rod when the collet is opened and rotate the rod with the spindle, though not of themselves advancing it. The other shell is fixed to a bracket extension on the headstock and does not rotate. It contains three feeder rollers whose axes make an angle of about 20 degrees with the axis of the spindle and are adjustable radially, as are those in the revolving shell. Springs keep both sets of rollers in contact with the rod when the collet is opened and allow for slight variations in the size of the stock. The rod

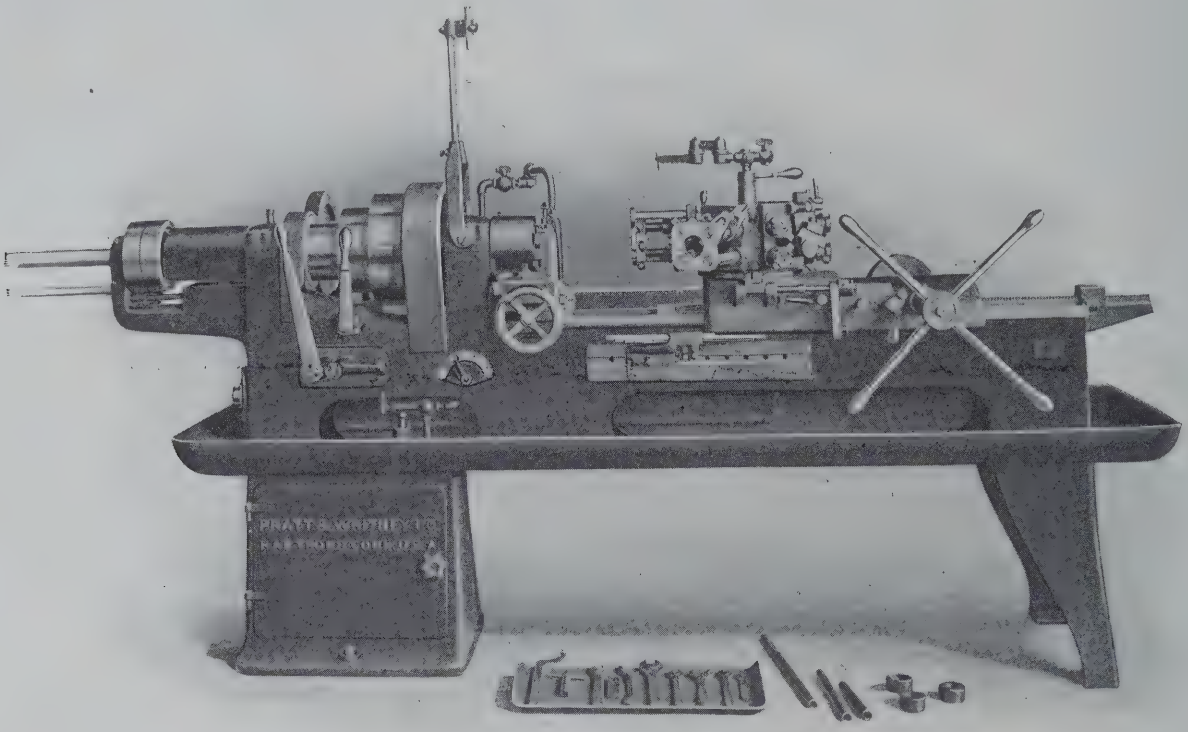


Fig. 1. The 2 x 26-inch New Model Turret Lathe.

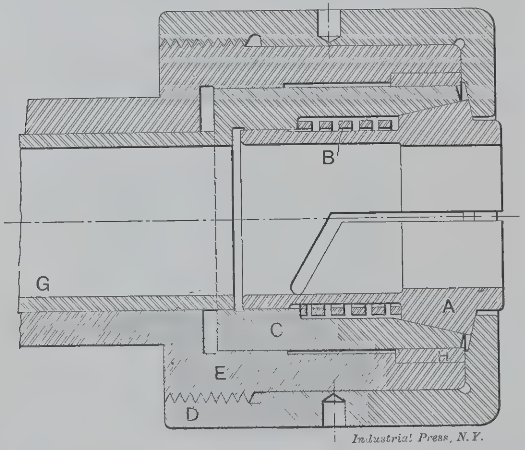


Fig. 2. Collet and Collet Closing Mechanism.

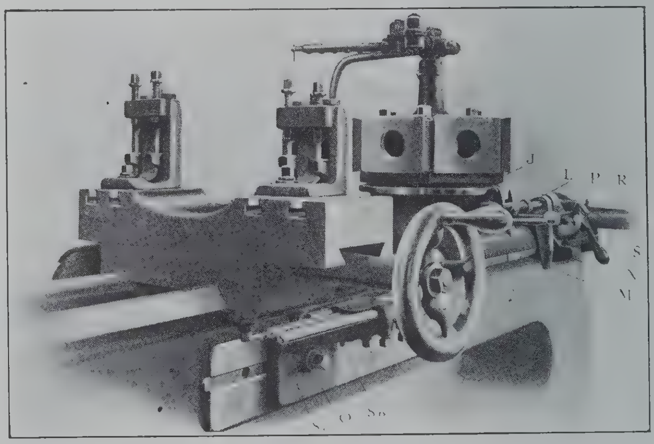


Fig. 3. Double Cross Slide and Turret.

being in contact with both driver and feeder rollers when the collet is opened, is given a forward motion until it comes in contact with the stop. When the collet is closed the feeder rollers are withdrawn from the stock.

The turret and turret slide are of the same general construction as has already been described for the smaller machines, but with the addition of a power feed. This feed is put into operation by pushing in the knob shown at *R* in Fig. 3; a movement of the short lever *S* throws it out of operation. The power feed is driven directly from the spindle by means of a Renold silent chain and has four changes of speed which are operated by a single lever located on the front of the machine below the headstock.

The double cross slide has gear-driven power feed with four speeds in either direction, automatic knock-off and hand feed operated through handwheel and screw. The power feed of the cross slide is thrown into operation by pushing a small knob on the front of the slide. It may be thrown out by hand at any point in the travel, while adjustable stops are provided for both hand and power feed. Each cross slide tool rests on two supporting steps which are in turn carried by screws, the knurled heads of which appear behind the square head setscrews. Raising or lowering one or both of these steps after the setscrews are slackened changes the height or angle—or both height and angle—of the cutting tool, after which it is clamped by the setscrew in the required position. The oil pump, which is located on the back of the headstock, is provided with a separate belt drive, rendering the oil supply entirely independent of the running of the spindle. The oil tank is located in the cabinet leg. The countershaft has three speeds, which are operated by a single shifting lever. It also has tight and loose pulleys for driving the oil pump.

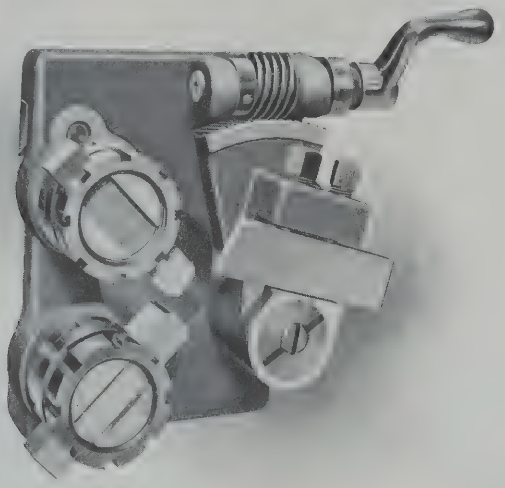
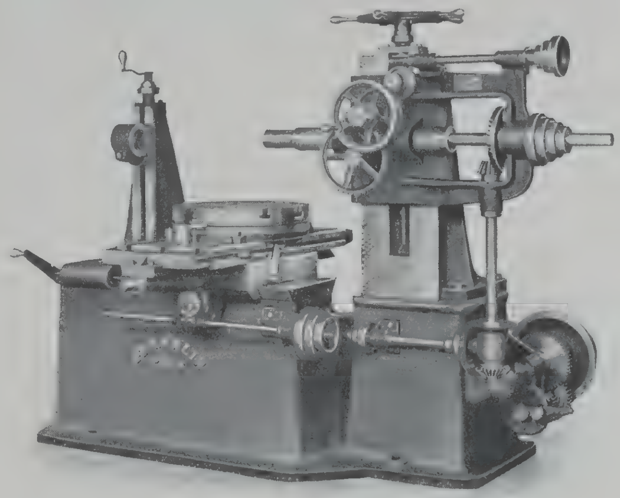


Fig. 4. Squaring and Recessing Tool.

The turret tools comprise the single and multiple roughing and finishing tools, similar in construction to those described for the smaller machines; pointing tool with cutter and back rest; the style *D* self-opening die-heads, with roughing and finishing adjustment; and single turning tool with tangent cutter having squaring and recessing attachment, cutter and back rest. The latter tool is illustrated in Fig. 4. The tangent cutter is mounted in a swinging holder, the top of which is made a segmental worm gear. This meshes with a worm that is operated by a crank on the back of the tool, which enables the cutter to be fed across a square shoulder, for finishing. When it is desired to use it as a recessing tool, in place of a forming tool, the cutter is drawn back until it clears the work. The turret is fed forward to the point at which the recessing is to begin and with the slide feed out of action the tool is fed in to the required depth of the recess. The slide feed is then thrown in until the desired length of recess is covered, when the tool is withdrawn. The use of this tool in many cases renders possible operations that would otherwise have to be done on a lathe as a second operation. All of the turret tools, with the exception of the die-heads, are dovetailed and gibbed to the several faces of the hexagonal turret. The hole through the back is of sufficient size to allow stock up to the full size of the largest collet to pass completely through the turret.

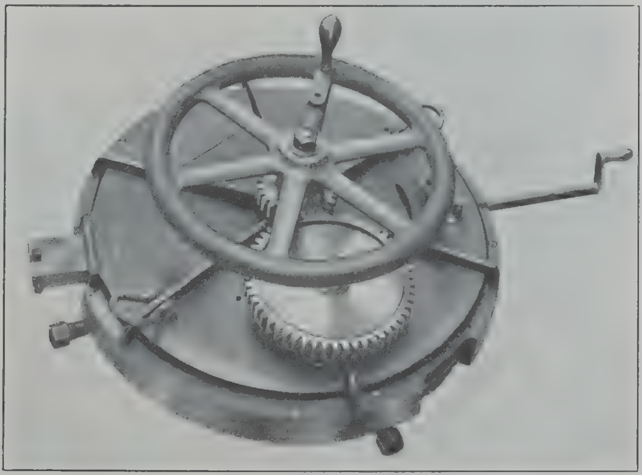
TOOL ROOM BORING MACHINE.

The photograph illustrates the new "Franklin" tool room boring machine, built by the Franklin Machine Works, Inc., Philadelphia, Pa. As its name implies, it was designed especially for all-around service in the tool room, but it is constructed rigidly and heavily enough for use in the shop for accurate boring, facing and milling. The spindle, which is of crucible steel, is two inches in diameter and has a wide range of feeds for boring and drilling. A feed is also provided for the table so that the machine can be used for milling. The lifting screw is provided with dial for micrometer adjustment of spindle head so that the milling cutters can be accurately set to any required depth. The circular table is designed to be readily placed on or removed from table, and is accurately graduated and aligned for work of great precision. The driving cone has three steps and is back-geared, thus giving changes of speed. The gears are steel castings and are of ample strength for any work within the capacity of the machine.


Tool Room Boring Machine.

PORTABLE JOINT FACING MACHINE.

The portable machine shown herewith is one that should be found useful in railroad shops and in jobbing establishments doing repairs to steam engines and boilers. It is a machine for refacing cylinder head joints, dome cap joints and similar parts that have become leaky in service and require machining before they can be made tight once more. The machine is made up of two disks, the upper one carrying a train of gearing and a slide on which is mounted the cutting tool, and the lower one the chucking screws for screwing out against the inner walls of the cylinder counterbore or the dome ring, to hold the machine in position. Two


Portable Joint Facing Machine.

of these screws are shown in the cut. Besides the gearing shown there are three reduction gears in the space between the two disks, to reduce the speed and to give power to drive the tool. The cutting tool is mounted on a steel slide which may be fed out automatically, or by hand. The crank seen in the illustration is for quickly moving the tool to the required position, then the feed clutch is thrown in and the crank removed, the machine feeding automatically as the handwheel is turned. The machine may be driven by hand or power; when power is employed a pulley or coupling is substituted for the handwheel. Hand power is generally used, as the time required for facing one joint is so short that it does not usually pay to connect to any other source of power. H. B. Underwood & Co., Philadelphia, are the manufacturers.

IMPROVED QUICK-FEED GEAR BOX.

Schumacher & Boyé, Cincinnati, Ohio, have recently redesigned and improved the feed gear box used on their lathes so as to greatly increase the range of feeds that can be obtained. In the photographs, Fig. 2 shows an end view, and Fig. 1 the front, of the arrangement for feeds and screw cutting that is now being used on all lathes of their make, from 16 to 32 inches inclusive. Power for operating the feed is delivered from the lathe spindle to the gear box, through reverse and intermediate gears, and thereby operates the spindle *A*, which extends the full length of the box. Upon this spindle, and keyed thereto, is a sliding gear which is moved by means of a yoke to any desired position along the spindle. Upon the upper edge of the yoke is a rack which meshes with a pinion keyed to the small shaft *B*. This pinion is turned by a short crank *H*, the handle of which contains a spring pin that may engage any of the eight holes in the feed disk *C*, thereby locking the slide-gear at any one of eight desired positions along the shaft *A*. The back of the yoke forms a plate, and has a series of eight holes corresponding to those in the feed disk and for each position of the pin in the feed disk a corresponding hole is brought into place in the slot shown in the front of the gear box. In a swinging bracket, which pivots around an extension of the lead screw *E*, is a cone composed of eight gears, which may be placed in mesh with the slide-gear. Upon the end of the gear cone shaft, which extends beyond the gear box toward the tail end of the lathe, is placed the gear that drives the lead screw so that by moving the slide-gear to its different positions, in mesh with the gears of the cone, eight different speeds of the lead screw are obtained. The swinging bracket is held in place by a spring pin in the handle *F*, which fits that hole in the yoke-plate which is exposed by the slot in the box, above referred to. These holes are so placed that when the pin is in position in the yoke-plate the slide-gear will be in mesh with the cone gears.

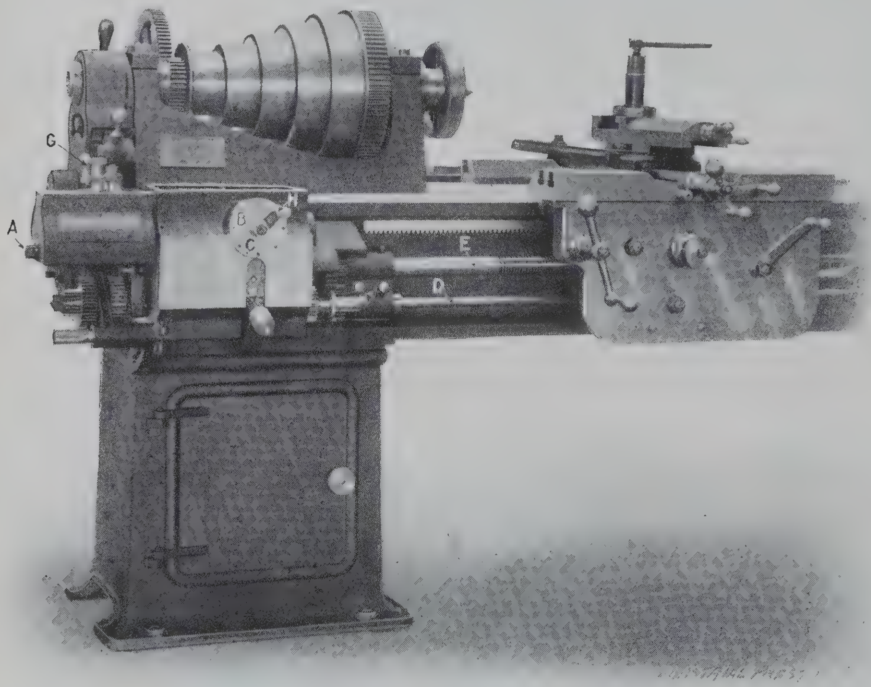
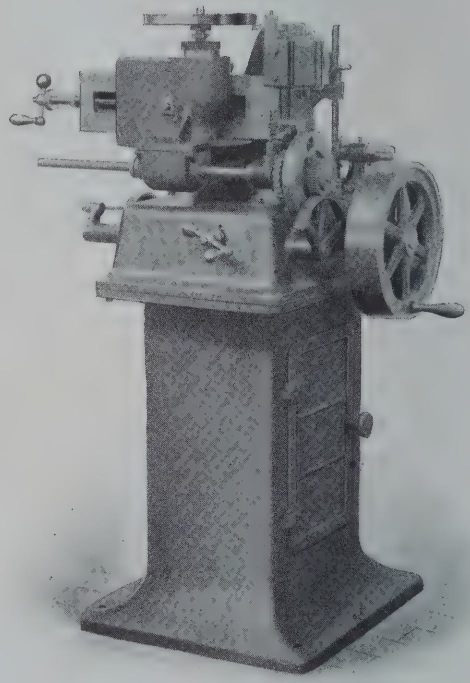


Fig. 1. Front View of Improved Feed Gear Box.



Universal Graduating Machine.

Upon the left hand end of the shaft *A* is mounted a second slide gear which, by a movement of the handle *G* over its dial, can effect five changes in the rate at which the spindle *A* is driven by the lathe spindle. This is accomplished by a set of compound gears that are mounted in the intermediate gear bracket.

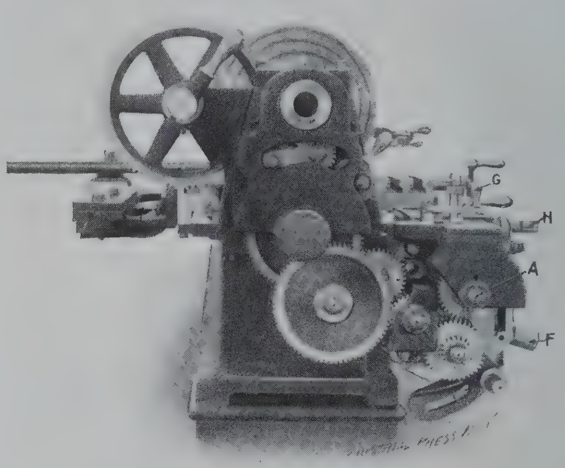


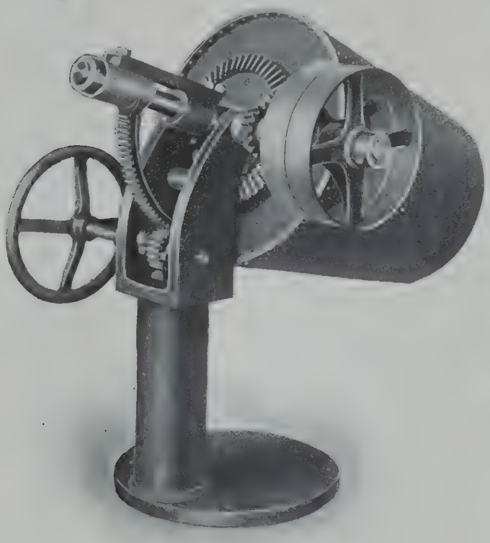
Fig. 2. End View of Improved Feed Gear Box.

To operate the mechanism: first disengage the pin *F* and allow the swinging bracket to drop, then move the crank *H* so as to bring the slide gear into mesh with the desired step on the gear cone, as indicated by the figures on the dial *C*, re-engage the pull pin with the hole in the yoke plate. This provides for any of the eight changes of speed obtainable from the gear cone. By dropping the intermediate gear bracket, the secondary slide-gear may be placed by means of the crank *G*, in mesh with the intermediate gears, so as to give five additional changes, and as these multiply those obtained from the gear cone we get a total of forty changes of speed available.

For feed changes it is necessary only to move a sliding gear along the feed rod *D* so that it will engage with a gear on the lead screw from which the feed rod is driven at a rate of four to one, *i. e.*, if we desire to obtain a feed of forty per inch, the lathe would be geared for cutting ten threads per inch when, with the feed rod in action, this feed would be obtained.

UNIVERSAL GRADUATING MACHINE.

The photograph on page 334 illustrates a new graduating machine that has been brought out by the Springfield Machine Tool Co., Springfield, Ohio. It is designed to divide circles into degrees or such divisions as are necessary to use in connection with screws of different pitches to allow each division to equal a movement of .001 inch. It is in some respects similar to an automatic gear cutter and, when once set for graduating a piece of work, is entirely automatic in its action. Provision is made, in connection with a cam, for long and short strokes so that the graduations may be more easily read. Owing to the fact that irregular pieces have to be graduated, such, for example, as compound slide rests, it has been thought better to hold the work vertically, since the use of a horizontal spindle would tend to destroy the accuracy of the results. The work is accordingly held on a vertical spindle, which revolves in a slide, adjustable to and from the graduating bar.



Oblique Tumbling Barrel.

The machine may be operated either by hand or by power, each revolution of the driving pulley representing one stroke of the graduating bar. Experience has shown that a speed of about one hundred strokes per minute will give the most satisfactory results. The graduating bar is operated by means of a small rack and pinion, driven through the intervention of four bevel gears, to which motion is given by a connecting rod whose upper end is connected to a link and whose lower end rolls on the cam, which is provided for giving the different lengths of stroke required for graduating operations. The link is so arranged that the cutting stroke of the graduating bar may be either upward or downward, according to requirements. This is accomplished by shifting the connecting rod from one side of the link to the other, while shifting it toward or away from the center results in a longer or shorter stroke of the graduating bar. The slide which holds the graduating bar may be swiveled to any angle, so that any form of surface which requires graduating, may be operated upon.

The indexing mechanism is positive—a pawl and ratchet being used to drive same and a form of pawl, plunger and ratchet is used to hold same in position during the cutting. Inasmuch as the indexing is done on the return stroke of the graduating bar and as all the movements bear a positive relation to each other, the danger from error is almost entirely eliminated.

The slide which carries the head for the graduating bar is adjustable up and down on the frame of the machine by means of the ball crank shown, which extends in the front of the machine. No provision has been made for relieving the cutting tool on the return stroke, inasmuch as it has been found that eminently satisfactory results may be obtained without this complication.

OBLIQUE TUMBLING BARREL.

The latest production of the Globe Machine & Stamping Co., Cleveland, Ohio, is the oblique tumbling barrel which is shown in the accompanying half-tone. These barrels are adapted for cleaning, brightening and polishing sheet metal stampings, small iron or brass castings, rods, pins, etc. They may be used for either wet or dry tumbling. By means of the hand-wheel the barrel may be raised to a nearly upright position or tilted down, as shown in the cut, so that the contents may be dumped out. It may be run in either of the extreme positions or at any intermediate position. Thus the most delicate stampings or castings may be finished without danger of distortion or breaking. A ratchet and pawl are provided which hold the barrel in any desired position. The ease and quickness with which the barrel may be emptied of finished work makes the tilting feature very desirable.

AUTOMATIC WORM AND SCREW THREADING LATHE.

The rapid and economical production of accurately threaded steel worms and screws of considerable size is receiving more attention from machine builders than ever before. High speed electric motors, and their use for driving heavy machinery, has created a large demand for worm devices, that being the principally adopted means of speed reduction, notwithstanding the high cost of the worm itself. Modern designers of automatic devices here find a fruitful field where a short time since it was thought no improvement could be made. Until recently no method of accurately threading worms and screws was known, other than with an engine lathe. The engine lathe is one of the oldest tools we have; very few radical changes have been made in it for many years; additions and modifications, to be sure, and automatic lathes for various purposes, but a threading lathe wherein all movements of spindle and feed were wholly automatic, requiring no attention of operator after he has placed the work between the centers has been reserved for later times.

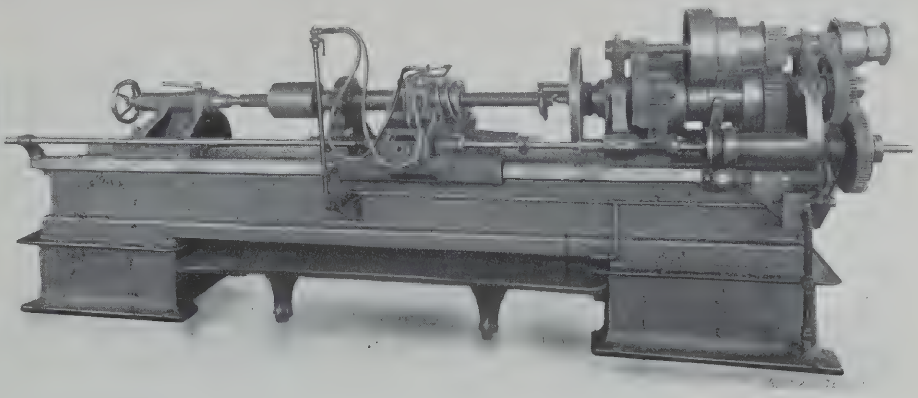


Fig. 1. Automatic Worm and Screw Threading Lathe.

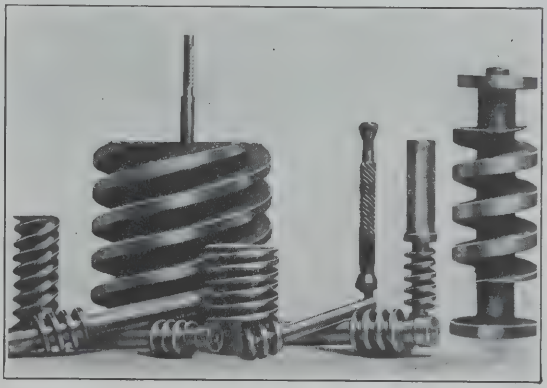


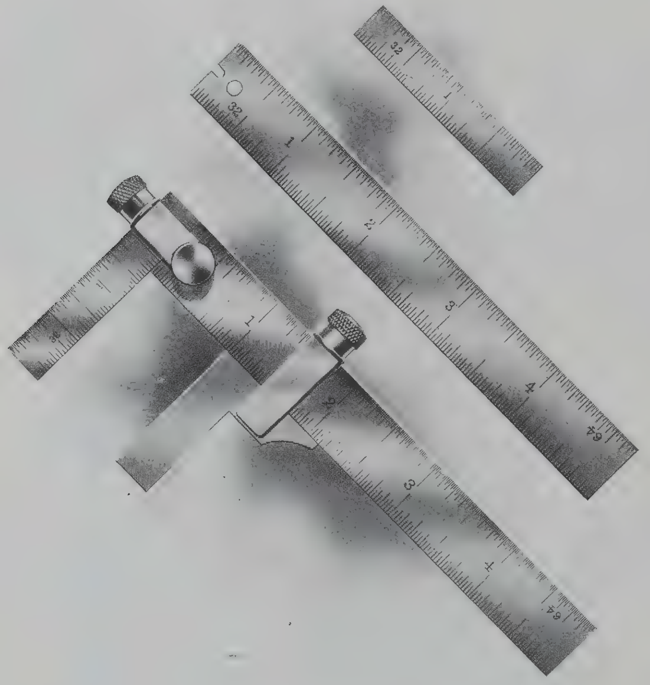
Fig. 2. Worm and Screws cut on Automatic Lathe.

The automatic threading lathe, for threading small screws up to about 2½ inches in diameter, has been built by the Automatic Machine Co., Bridgeport, Ct., for several years and now prompted by the demand above referred to and profiting by their experience with the smaller sizes, they have recently brought out a large machine for automatically threading screws and worms up to 10 inches in diameter. This machine, which is similar in its general features to the engine lathe, partakes in general of the design of the smaller machines that have been built by the company, but with such additions as are made necessary by the increased size of the work which is handled. The cut shows a back view of the machine, giving a very good idea of the automatic mechanism and the extra heavy gears that have been provided both for the drive and feed incidental to the increased duty of the machine. The lead screw is located in the center of the bed and as near to the work as possible. The carriage carries four threading tools, which are held in blocks in such a manner that they may be quickly removed, sharpened and replaced without affecting the accuracy of their position. One of these tools is used for roughing, two for siding (thus permitting the use of angular or shearing cutting edges), and one for finishing. The cut feed is graduated so that the last few passes of the tool over the work are with finishing or scraping chips, thus insuring an extreme smoothness of finish.

Fig. 2 shows a few samples of the work done on this lathe. The largest worm shown is 8 inches in diameter, 6 inches long, 6-inch lead, quadruple thread, 15-16 inch deep; this was threaded in 93 minutes. The next smaller worm is 3½ inches in diameter, 6 inches long, 1¾-inch lead, single thread, 1⅛ inch deep, and is peculiar in that the threaded portion is between flanges. Time for threading this worm, 74 minutes.

COMBINATION CALIPER SQUARE, DEPTH GAGE AND STEEL RULES.

The Billings & Spencer Co., Hartford, Conn., have recently placed on the market the combination tool shown in the accompanying illustration. An ordinary 5-inch steel rule is drilled and slotted at one end so that a small clamp may be readily attached. A 2-inch rule placed under this clamp is held squarely across the end of the larger rule. Sliding on this larger rule is a caliper jaw which in conjunction with the small rule makes a convenient caliper square. By removing the 2-inch rule and its clamp, and using only the sliding jaw on the large scale, the tool is at once converted into a depth gage. In fact, two depth gages are obtainable, for if the sliding jaw be removed the short scale may be employed as a depth gage by using the larger rule as a base and sliding the small rule through the end clamp. This is often convenient for use in holes or slots that are too small for the large rule to be inserted. The tool is very handy for machinists and toolmakers, combining, as it does, the two above tools and at the same time providing two ordinary rules for general use when neither the caliper or depth gage is required.



Combination Caliper and Steel Rules.

PERSONAL.

Mr. E. R. Markham, well known to our readers as the author of the series of articles on the treatment of steel, has resigned his position in the Mechanic Arts High School, Springfield, Mass., to accept one with the J. H. Williams Co., Brooklyn, N. Y., beginning March 1st. Mr. Markham has had 25 years' shop experience. He served an apprenticeship under his father, Russell Markham, who for 40 years was in charge of the machine department of the Lamb Knitting Machine Co. Then he was diemaker with the Barney & Berry Skate Co., and with the Faye Tool Co., both of Springfield, Mass. Later on he took charge of the fine tool department and of the milling work on guns, etc., at the J. Stevens Arms & Tool Co., where he remained for eight years, leaving them to take charge of the machine department at the Lamb Knitting Machine Co., makers of the Spalding bicycles. Here he was shortly given charge of the hardening, the small parts and the grinding departments. Later he took charge of the tool department, where it was his duty not only to superintend the making of tools, but also to design all tools, jigs, fixtures and special machinery made in the shop. The method used by him for hardening the gears was adopted by several of the largest concerns making chainless bicycles. After five years with this firm, he went to the Waltham Watch Tool Co., as superintendent, and from there to the Mechanics Arts High School.

* * *

OBITUARY NOTE.

James Oscar Nixon, late engineer and manager of the silent-chain department of the Link-Belt Engineering Co., Philadelphia, died on December 27, 1902, aged 23 years. Mr. Nixon had already achieved a marked success in his work and gave every promise of a most successful career. He was a native of New Orleans and a graduate of Tulare University of that city. Mr. Nixon had been in the employ of the Link-Belt Engineering Co. three years, during which he showed that he possessed great mechanical genius. He was the author of the article on the Renold chain, which was published in MACHINERY, in the December issue.

* * *

FRESH FROM THE PRESS.

ELEMENTS OF ELECTRICAL ENGINEERING. A first year's course for students. By Tyson Sewell, A. I. E. E. 332 pages, size 5¼ x 8 inches. Illustrated with 204 cuts. Published by Crosby Lockwood & Son, London, and D. Van Nostrand Co., New York. Price $3.00 net.

This excellent work is based upon courses of lectures given by Prof. Sewell to students at the Polytechnic, Regent St., London, who were qualifying as electrical engineers. The treatment of the subject is as non-mathematical as the nature of the science will permit, and still give a student a substantial groundwork for the advanced work necessary to the degree of electrical engineer. The book is divided into sixteen chapters, the first being, of course, an exposition of Ohm's law, which is the fundamental principle of electrical science. The explanation employs the hydraulic analogy in which the flow of water in a closed pipe system is compared to the flow of the electric current in a circuit. A pump in the pipe system, which causes the water to circulate round and round, corresponds to the electric generator or dynamo. The succeeding chapters take up in order: Units employed in electrical engineering; series and parallel circuits; heating effect of the electric current; the magnetic effect of the electric current; the magnetization of iron; primary batteries and accumulators: ammeters, voltmeters and ohmmeters; electric meters; electric measuring instruments; electric measurements; arc lamps; incandescent lamps; continuous current generators; and direct-current motors. The work is one that we believe will be highly appreciated by many young men who are looking for a sound treatise on electricity that will give them something more than the bare fundamental principles, and yet written so as to come within the range of ordinary mathematical comprehension. A careful study of the book will, in our opinion, furnish a good working knowledge of electricity and one that no one beneath the rank of electrical engineer, need be ashamed of.

HARDENING, TEMPERING, ANNEALING AND FORGING OF STEEL. By Joseph V. Woodworth. Published by Norman W. Henley & Co., 132 Nassau St., New York. 288 pages. Illustrated. Price, $2.50.

This volume by Mr. Woodworth takes up in its various chapters the selection of steel, its annealing, hardening, tempering, and case-hardening, as indicated by the title, with supplementary chapters upon miscellaneous methods used in metal-working such as forging and welding, grinding tools, etc. The author had in view the preparation of a volume treating this subject in a practical manner, and was led to prepare the work from the fact that there is very little published information upon the subject outside of the technical press. Unlike Mr. Woodworth's book, "Dies, their Construction and Use," which we reviewed last month, this work is largely a compilation and contains a great number of items that have been gathered from various sources and systematically arranged. These have been taken mainly from the leading technical papers or have been obtained from master mechanics or others connected with machine shop work, and from catalogues. While the book is fully illustrated the cuts are mainly from catalogues, so that its general appearance is not as good as that of "Dies, their Construction and Use." It appears to be carefully arranged, however, and contains many notes and data that would be of assistance to any mechanic.

MACHINERY.

March, 1903.

AMONG THE SHOPS.

NOTES OF TECHNICAL INTEREST FROM BOTH EAST AND WEST.

It has been learned by experience in the construction of vertical engines that the cylinders, especially if they are of large size, should be bored in a vertical position. This is owing to the fact that when a cylinder is placed horizontally a certain amount of settling takes place owing to the weight of the casting and if it is bored in this position and then placed vertically, so that this weight-strain is removed, the result will be an oval hole. As all of the large marine engines are of this type, a vertical boring machine is consequently one of the necessities of a marine engine shop.

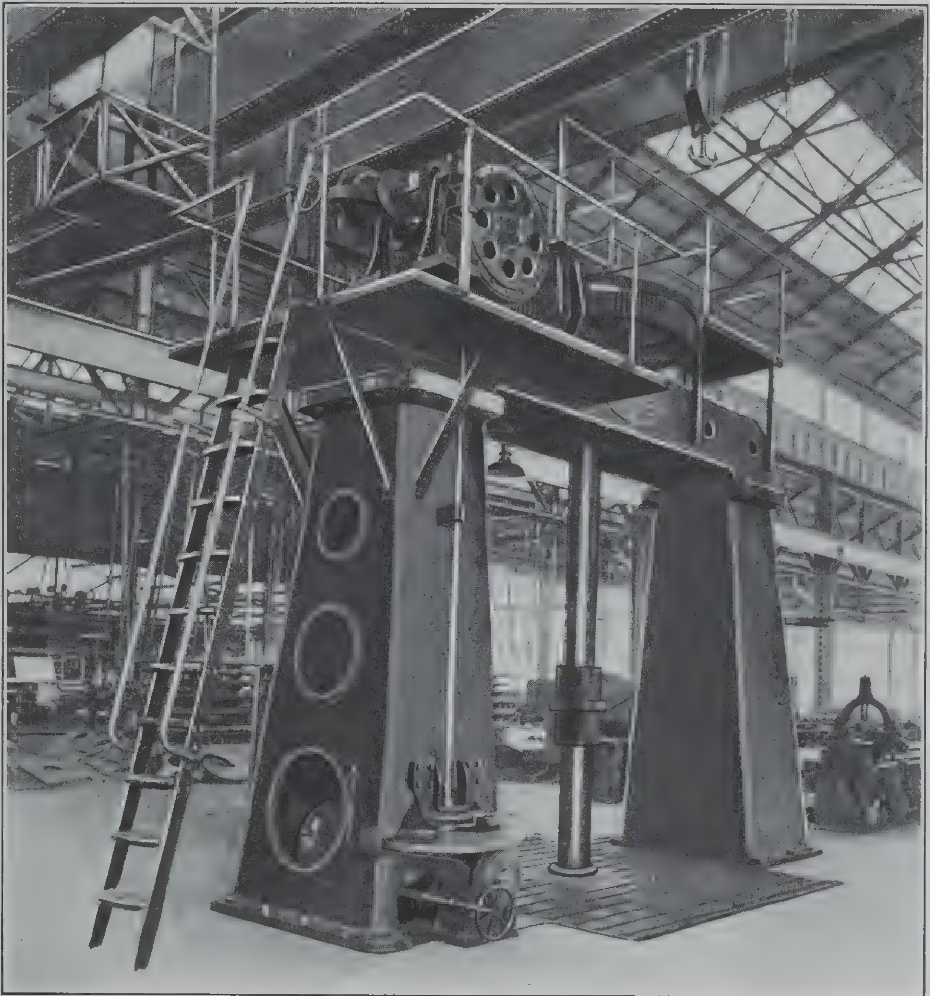


Fig. 1. Large Vertical Boring Machine designed and built at the New York Navy Yard.

The engines for the new battleship "Connecticut," which is now being built at the New York Navy Yard, will be the product of the Department of Steam Engineering connected with the Yard, and will be of the vertical, triple-expansion type, the low-pressure cylinders having a bore of 61 inches. It is for the purpose of boring these cylinders that the Department has designed and constructed the vertical boring machine illustrated in Fig. 1. The extreme height from the bed plate to the under side of the connecting tie is 10 feet 11½ inches, while the width between the upright columns is 10 feet. It is placed upon a bed of concrete which, in turn, rests upon a pile foundation.

The machine is electrically operated, being driven by a Westinghouse, two-phase, alternating current motor of 15 horse power capacity, running at a speed of 720 revolutions per minute. The motor is placed inside of one of the column legs, upon the back of which, at a convenient height, is mounted the switchboard.

Since this motor starts at full speed, friction driving mechanism has been employed and a detail of the motor and friction drive is shown in Fig. 2. The armature shaft is connected by a coupling to the shaft *A*, upon which is mounted the friction driving pinion *B*, so arranged that it may be drawn in or out across the face of the friction disk by means of a screw and hand wheel, thus increasing or decreasing the speed at which the shaft *E* is driven. The pinion *D*, which is mounted on an extension of the driving shaft bracket, serves simply as an idler for supporting the outside of the friction disk and does not move across its face as does the pinion *B*. Both of these pinions are of cast iron, having a circumferential groove lined with leather which runs in contact with the cast-iron friction disk. The disk *C* is withdrawn from the pinions or forced into contact with them with any degree of force by means of the hand lever *F*, which rotates the nut *G* and thus moves the disk up or down. The thrust of the disk is taken upon a ball bearing collar and at all places in this machine where a thrust is encountered ball bearings have been provided.

From the friction disk the driving shaft rises to the operating platform from which all the movements of the machine can be controlled. At this platform the vertical shaft is geared with one placed horizontally carrying a pinion from which is derived the power to operate the system of gearing that is used to drive the boring bar. The web of the first gear in the system is bored out to form a friction clutch so that the driving mechanism may be engaged or released without stopping the motor. Upon the end of the horizontal shaft, above mentioned, is a friction disk from which the feed is driven. A handle, which may be seen at the left of the mechanism, is used for moving the friction pinion to any position across the face of the disk in order to give the desired rate of speed. The direction of feed is changed by shifting the pinion from one side to the other of the friction disk. In addition to the change in feed that is accomplished in the above manner, a set of change gears is provided for increasing the range of feed. At the top of the bar will be seen the two large spur gears by which the bar and feed screws are driven. The lower and broader gear is keyed directly to the bar while the upper one is independent of the bar and contains an internal gear that meshes with the pinions mounted on the ends of the two feed screws.

Three boring bars, having diameters of 6, 10 and 14 inches respectively, are provided for use with the machine, the 6-inch size being used for boring the stuffing boxes of the large cylinders. The removal or exchange of these bars is easily accomplished by use of one of the electric cranes by which the machine is served. When not in use the bars are stood vertically in a bracket which is fastened to the further side of the right-hand column. For facilitating this handling of the bars an eye bolt is permanently attached to the top of each bar, as will be seen in Fig. 3, which is a detail of the 14-inch bar. Two feed screws extend along opposite sides of the bar and fit bronze nuts in the sleeve which is shown at about the center of the bar. To this sleeve are fastened the different heads that carry the boring tools. At the top of each feed screw will be seen the pinions which engage with the internal driving gear.

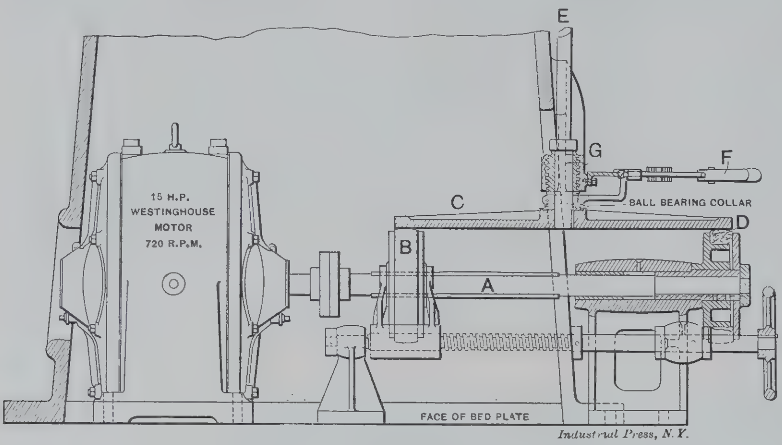


Fig. 2. The Motor Drive.

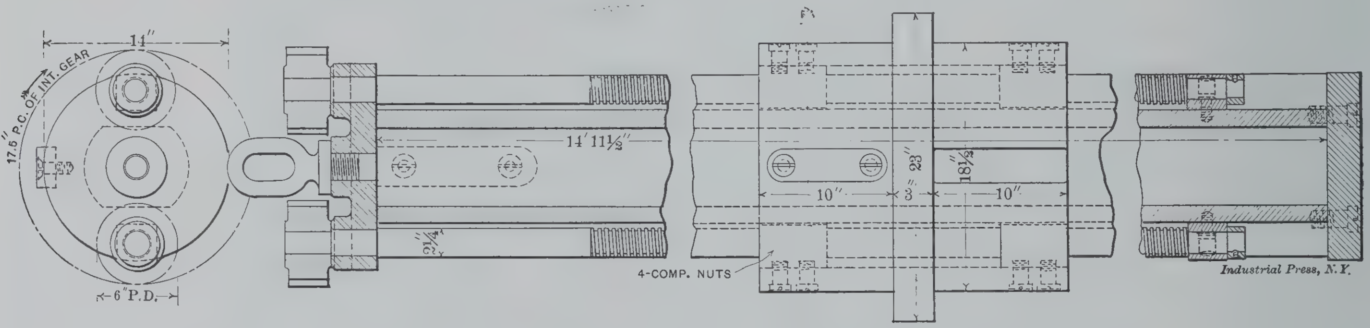


Fig. 3. Details of Boring Bar.

This machine was designed and built complete by the Department of Engineering at the Navy Yard, under the direction of Commander J. A. B. Smith, and in design and finish compares very favorably with the work of the regular machine tool builders.

NOTES ON MACHINE CONSTRUCTION AT THE POND MACHINE TOOL CO., PLAINFIELD, N. J.

One of the many problems that some machine tool manufacturers have to solve, particularly those building heavy machinery, is the economical handling of parts larger than the capacity of their largest shop tools. Again there are machine parts that, for the smaller machine sizes even, are awkward to handle, and which, if treated in the manner that naturally would be followed for the particular operation required, would mean the tying up of shop tools of a capacity all out of proportion to the extent of the operation. That is to say, a large tool might be required to do a machining operation comparatively small in extent and one that would take but little time after the piece was chucked. More time would be consumed in chucking than in the actual operation. This applies with some force to facing the outer bearing rings on the bases of boring mills, large or small.

In the April, 1900, issue we briefly described how Wm. Sellers & Co. bored and turned the bases for the huge 28-foot boring mills built by them for the Westinghouse Companies. In this case a comparatively small boring mill in the shop was stripped of its housings, leaving only the base, table and driving machinery. The base to be bored and faced, was placed upside down over the stripped mill and supported at the four corners on suitable pedestals. A cross rail fastened to the lower mill table carried a slide and tool which did the facing of the bearing ring. This job was, of course, an unusual one and required unusual procedure, but it very well illustrates some of the expedients that often have to be resorted to. In this case something of the kind was absolutely necessary, as there was no boring mill or pit lathe large enough to swing the base.

The method regularly employed by the Pond Machine Tool Co. for facing the outer bearing rings on all their boring mill bases, is well worth a short description. The bases are planed, bored for the table spindles (this is done on a horizontal mill with a boring bar) and, in fact, all the other machine work is done before the bearing ring is faced. The base without the housings is erected over a suitable shop pit, and the driving works and table placed in position. But the table is not lowered to its normal position, being instead supported on its step bearing a distance of four or five inches above it, as shown in Fig. 4. Being driven by a spur pinion meshing in an internal gear, the table may be revolved by power in this position by belting to the cone pulley in the usual way. An angle casting *C*, carrying a slide and cutting tool *D* at its lower end, is bolted to the table *A*. Now by driving the table by power through the regular channel, the bearing ring is quickly and accurately faced and that without requiring a large boring mill for the job. The operator feeds the tool across the cut a short distance for each revolution as the slide comes around to him, and to take a fresh cut he simply lowers the table by means of the step-adjusting screw *B*.

The method employed by this company for cutting the internal gear teeth of boring mill tables and large geared lathe faceplates is also of some interest. It is done on a slotter which is specially rigged for such work. A table *A*, Fig. 5 (which shows a top view) is bolted to the regular circular table. The table, it will be observed, is elongated to the right, forming a tapered wing or arm. Through the middle of this part a slot is planed and tapped holes are located at intervals along each side. The slot and holes are for locating and clamping the latch *D* and its block in the various positions required for the different sizes of index plates, *B*. The internal gear blank, *C*, to be cut, is mounted on the index plate so that, of course, both turn together when indexing. The cutter bar and tool mounted on the slotter ram, are shown at *J*. The tool is relieved on the "up" stroke by means of a compound nut *G* and suitable connections to operate it at the right time. This nut forms the thrust bearing for the feed screw *F* and is externally threaded to fit a coarse thread cut in the base. Turning the nut *G* in either direction, gives a longitudinal movement to the feed screw *F* independent of its regular feed motion. The feed screw is operated from the opposite end and is splined so that it is free to slide longitudinally to accommodate the motion communicated to it from the nut *G*. In this manner the table carrying the gear is moved away from the tool a short distance just as the "down" stroke is completed and back again at the end of the up stroke without interference with the regular feed motion, which is accomplished by ratchet action in the usual manner. The oscillatory movement of the feed motion is communicated to the nut *G* by the levers and shaft *H*.

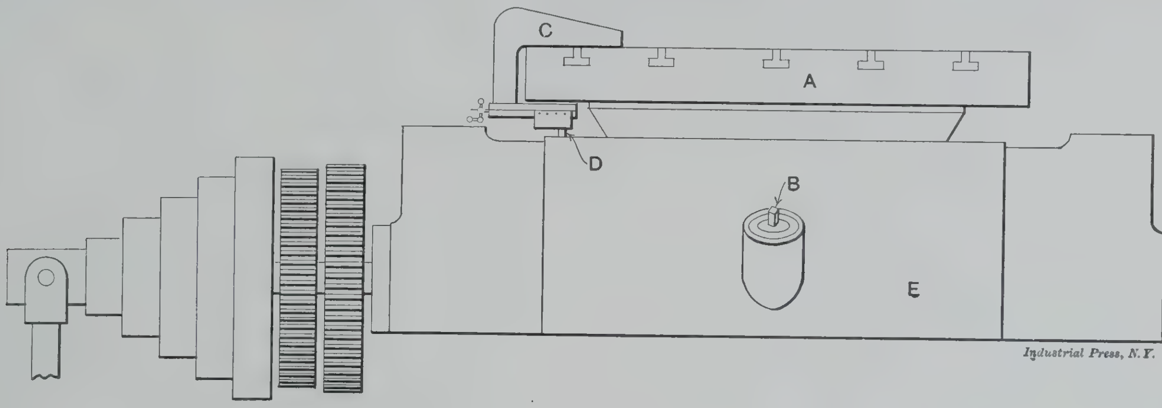


Fig. 4. Method of Facing the Outer Bearing Rings of large Boring Mills.

NEW FOUNDRY OF THE VILTER MFG. CO., MILWAUKEE—HEATING SYSTEM—CHARGING THE CUPOLA.

The Vilter Manufacturing Co., Milwaukee, Wis., builders of Corliss engines and refrigerating machinery, have been occupying a new foundry building for some time past, designed by their superintendent, Mr. Theodore O. Vilter. Before proceeding with the erection of the building Mr. Vilter visited a large number of foundries in different parts of the country and incorporated in his design such ideas as he believed to be of practical value to a concern engaged in heavy engineering work. The foundry is 280 by 110 feet in area and is served by two Pawling & Harnischfeger cranes, one of 30-ton and one of 15-ton capacity and both of 60 feet span. The building is arranged in three bays, with monitor roof over the middle bay. The side walls have windows extending nearly from floor to roof, the openings being as large and as near together as considerations of strength will allow. The walls are of brick laid to form pilasters about 20 feet apart. The pilasters encase steel columns which support the roof, thus making it necessary for the walls to be self-supporting, merely, and allowing a much greater window space than if the walls had to be built to sustain the weight of the roof. The sides of the monitor roof have windows for lighting the central portion of the building and for providing ventilation. These windows are all connected with rock shafts that can be operated from the floor and may be conveniently opened or closed as often as required to keep the air pure and free from smoke.

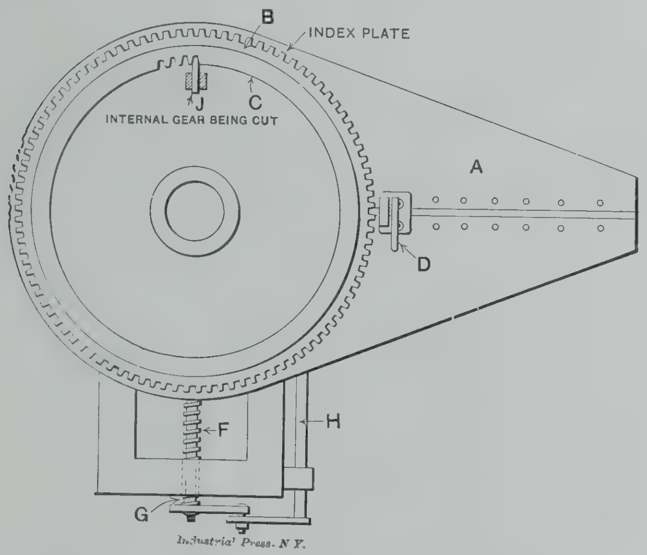


Fig. 5. Cutting Internal Gear Teeth of Boring Mill Tables.

The building is heated by the forced blast system, air being drawn in from the outside and forced over steam coils and thence through ducts to different parts of the building. In the arrangement of the ducts, however, an important departure has been made from the usual arrangement of sheet iron pipes commonly employed in manufacturing establishments for conveying the warm air to the different departments. The passage for the air in this case consists of a bricked-up subway extending along the two sides of the foundry, close to the foundation walls, and below the floor level, with a connecting passage running from one side to the other at a distance of about 25 feet from one end of the building. The heating coils and blower are situated near the center of one side of the building and the air is delivered to this underground duct and escapes to the interior of the foundry through registers or gratings at suitable intervals. In Fig. 6 are two sectional views of the duct, one taken at a point where it passes one of the pilasters and the other through the passage connecting the ducts on the two sides of the building. The advantage claimed for this arrangement is that it delivers the heat where it is wanted, viz., next to the cold walls, and that as the hot air enters from or near the floor level it meets and warms any cold air descending from the windows or outer walls and so prevents drafts and maintains a uniform temperature throughout the structure. The top of the duct is covered by cast iron plates, any of which may be removed and gratings substituted. The connecting passage is entirely below the floor level, and is covered with plank and boards, with a layer of paper between and with several inches of foundry sand on top.

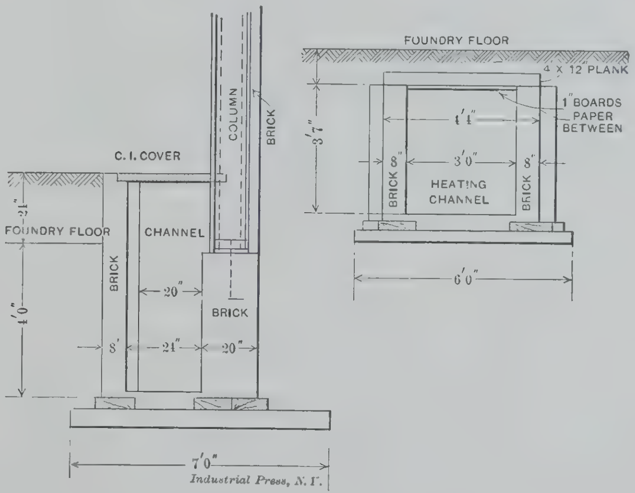


Fig. 6. Heating Ducts of Foundry, Vilter Mfg. Co.

In Fig. 8 is shown the arrangement of the two cupolas, blower room, etc. The main, or outer wall of the foundry is at *A*, *A*, and at *B*, extending both into and outside of the foundry is the cupola room, which is bricked up and provided with doors by which it can be shut off from the foundry, to keep out the dust when dropping the bottoms of the cupolas. The cupola room is two stories high, the upper, or charging floor being of steel. Next to the cupola room on one side is the blower room, containing a Roots blower, driven by a steam engine. The engine is used in preference to an electric motor for this, because it is necessary to vary the speed of the blower to adapt it to either or both cupolas, or to differ-

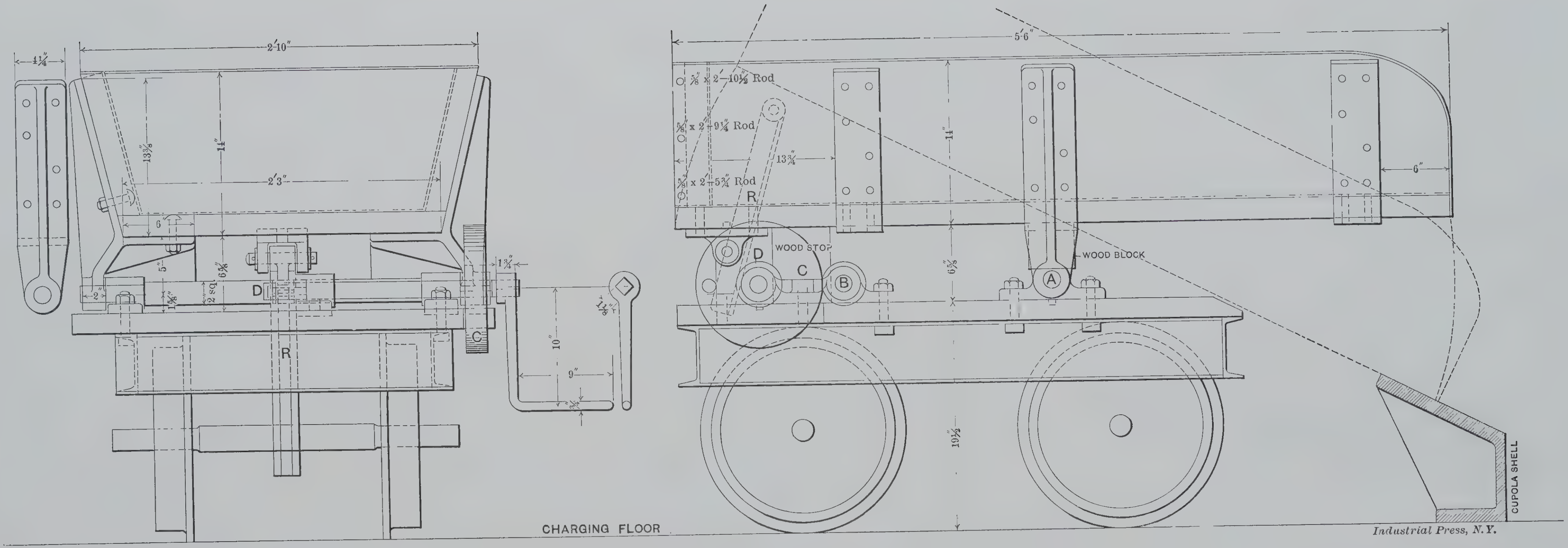


Fig. 7. Details of Charging Car for Foundry Cupola.

ent charges. Directly over the blower is the heating apparatus in which the fan is motor-driven. At night, if there is no current available for operating the motor, the engine can be disconnected from the Roots blower and used to operate the heating fan. On the other side of the cupola room are the lavatory and closets. Several sand sheds are built along the outer wall to the left, Fig. 8, outside of the building, one of which is indicated in the plan.

In charging the cupolas, a car bearing the pig or scrap iron and coke is pushed along the track *T*, *T*, to a pneumatically-operated elevator in the corner of the cupola room and raised to the charging floor. There it is wheeled off onto the turn-table *K*, and by its aid is aimed toward the charging door of one of the cupolas, when it is pushed off onto the charging floor. When the charge is wanted its journey is continued to the cupola and the load dumped.

The charging cars were designed by Mr. Vilter and are shown in detail in Fig. 7. The framework of the truck is of channel iron beams, to which are bolted the bearings for the wheels and supports for the body. The body is of two-inch plank, lined with sheet iron and is pivoted a little back of the center by means of suitable supporting arms, which have a bearing on two pins, one on either side, and held by brackets, *A*, bolted to the frame of the truck. The pivot arrangement is for the purpose of dumping the charge into the cupola, and the body is tilted up through the gearing at the rear of the truck, operated by the wrought-iron crank shown in the left-hand view. The pinion *B* is on the crankshaft and meshes with gear *C*, which is on a shaft extending to the center of the car. On the inner end of this shaft is pinion *D*, which meshes with rack *R*, attached to the body. The

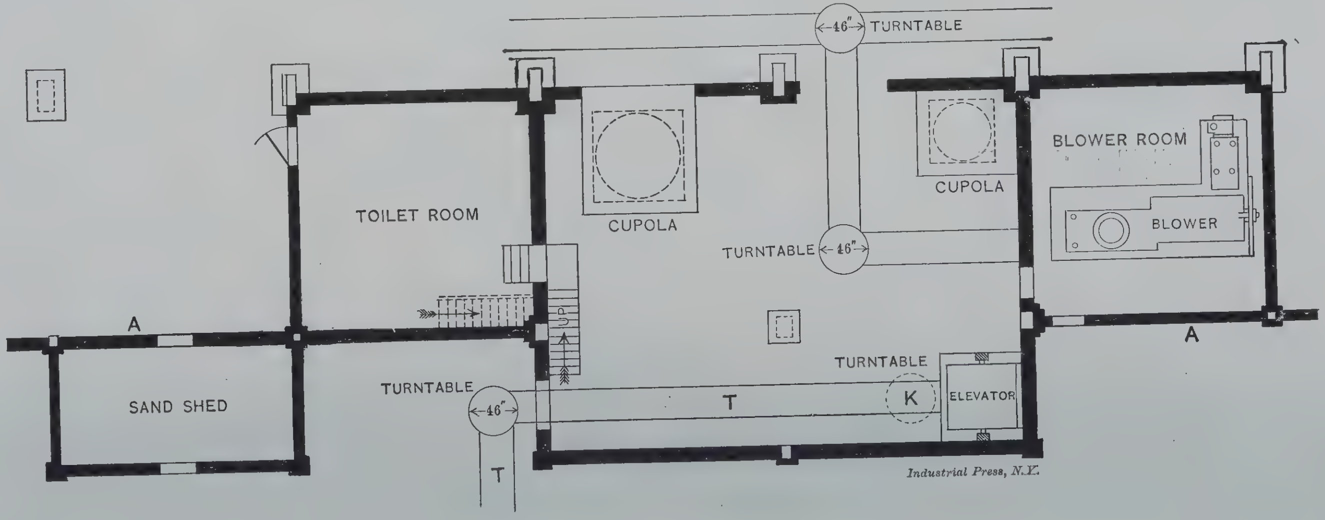


Fig. 8. Showing Cupola Room of Foundry.

rack is shown dotted in the right-hand view and in the position in which it is indicated the car body would be raised so as to dump the charge. The pinions *B* and *D* have 15 teeth, ¾-inch pitch each, and gear *C* has 45 teeth. There are several of these cars, so that a sufficient quantity of material may be accumulated on the charging floor without any re-handling, such as would be necessary if the cars had to be unloaded before charging.

At one end of the foundry are the core ovens, with which the foundry is well provided. There are five ovens, ranging from 26 feet 6 inches by 20 feet 6 inches by 14 feet high to 4 by 5 feet and 6 feet high. The two largest ovens have two tracks for running in the trucks carrying the cores, and the next smaller has one track. All the furnaces for the ovens are depressed four feet below the floor level and project above the floor level on an average about two feet. The largest oven has two furnaces, with grate areas 2 feet 6 inches by 4 feet. The next oven has one furnace, with grate 3 feet by 5 feet. A passageway extending along the rear of the ovens is depressed four feet to correspond with the level of the furnaces and all the furnaces are located so they may be fired from the passageway.

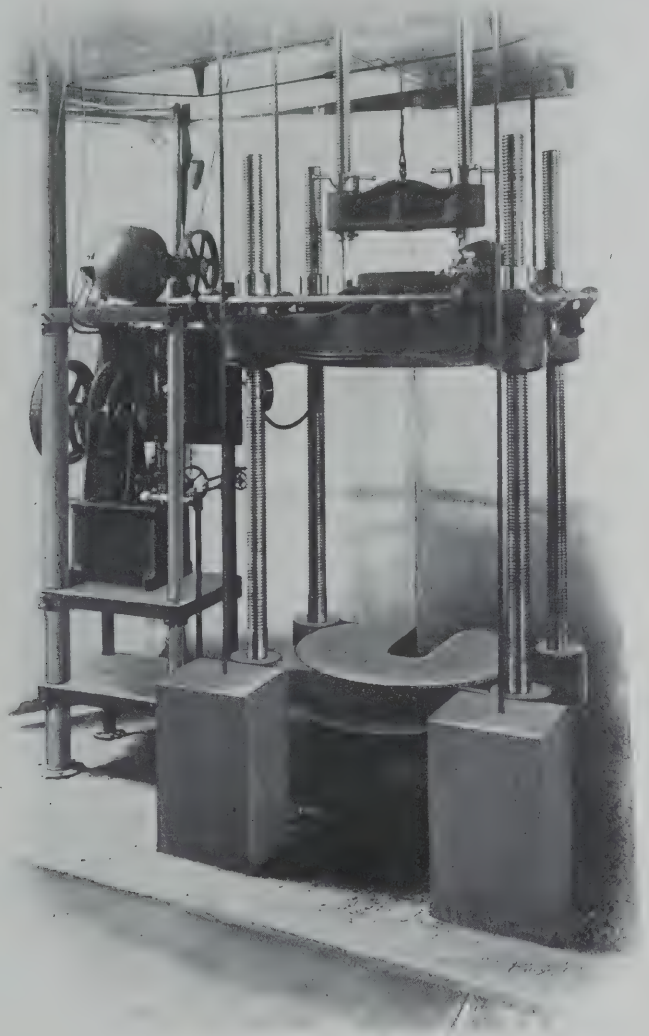


Fig. 9. Hydraulic Press Driven by Motor.

The feature of the ovens most appreciated by the workmen, however, is the arrangement for raising and lowering the doors. The usual spectacle of half-a-dozen workmen trying to raise a hot iron door 10 or 15 feet square is not experienced here. At the rear of each furnace is a long cylinder in which there is a plunger operated by the compressed air system of the foundry, by which the doors are raised and lowered through cables which pass over sheaves and connect with them. The cylinders are in all respects like those employed for pneumatic hoists, and operate on the same principle.

NORTHERN ELECTRICAL MFG. CO., MADISON, WIS.—LARGE POWER PRESS ELECTRICALLY DRIVEN.

The Northern Electrical Manufacturing Co., Madison, Wis., have in use at their works an electrically-driven hydraulic press, two views of which are shown herewith. The machine was designed by their superintendent, Mr. T. E. Drohan, to meet the special requirements of dynamo and motor manufacturing and was built at the Northern Electric shops. The chief work for the press is compressing the laminated sections of which the armature cores are built, preparatory to bolting them solidly together, but it can be used equally as well for forcing mandrels into hubs or for any of the work of this character that must ordinarily be done around the shop. Small or large work can be handled with equal facility.

The press consists of two parts, the press proper, shown at the right in Fig. 9, and the operating and controlling mechanism on the stand at the left in the illustration. The press proper has the usual corner screws as its "backbone." The pressure is applied by two hydraulic cylinders and plungers, under the platen, or lower head, and on the floor level. The four corner screws are four inches in diameter and are rigidly connected to the cylinder casting at their lower ends, and support the head at their upper ends. They also serve to guide the platen in its vertical motion and prevent any "side wind" if the loading should be eccentric.

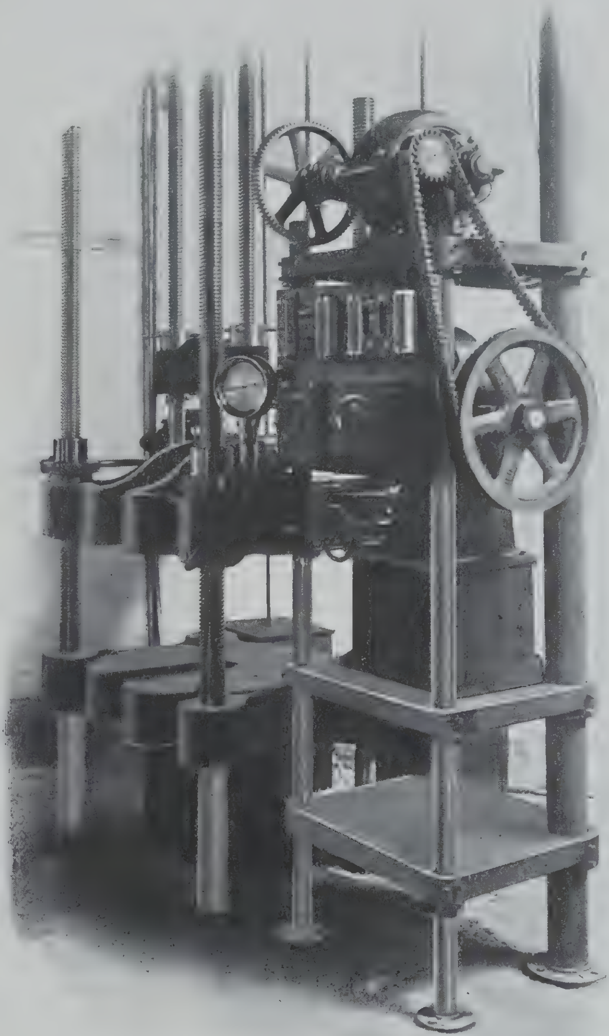


Fig. 10. Showing the Motor and its Connections.

The upper head is balanced by the two weights in the foreground in Fig. 9 and is raised and lowered by a one horse power electric motor placed on top of the head casting. There is a cylindrical nut supported by a bearing in each corner of the head which is so held that it can have no endwise movement, but which may be rotated by power in either direction to raise or lower the head, as required. The method of rotating these nuts is by the horizontal shafts extending around three sides of the head and which are plainly visible in both views. Each nut has spiral gear teeth cut on its outer surface which mesh with gears on the horizontal shafts. The connection between the three shafts is by bevel gears, so that they all move in unison, and they receive their motion from the motor mentioned, through a worm and worm gear.

In designing this press the idea was to use standard apparatus, as far as possible, and to arrive at the desired result by grouping these units. While certain parts like the heads and screws were special, the motors, controlling apparatus, hydraulic pump, etc., were all standard. The latter is one of the regular pumps manufactured by the Watson-Stillman Co., New York, and is chain-driven by a 2 horse power motor placed on the upper shelf of the stand, directly over the pump. At the front of the stand is the controller board which contains the switches and starters used for starting, stopping and reversing the motors.

The time-saving feature of the machine is obviously the power adjustment for the upper head. As the head can be brought down to the work by power without any effort on the part of the operator, the time and labor that would ordinarily be expended in blocking up the work or in moving the head by hand is thus saved.

Both the upper head and lower head or platen are slotted on one side to allow the passage of an arbor or shaft which is being pressed into or out of a piece of work. For very long work of this character there is a supplementary head, Fig. 9, p. 341, consisting of a stiff casting supported by two screws extending upward from the main head of the machine. This cross piece is moved up or down by hand adjustment.

The press has a maximum capacity of 400,000 pounds.

* * *

A novel feature of the equipment of the San Francisco fire department is a steel drill tower for practice purposes. This tower is four stories high and has fire escapes down the outside, like those of a building, and is provided with a standpipe such as are now to be found in all modern structures for business purposes. On certain days a number of firemen are detailed to practice with scaling ladders, water towers, fire escapes, etc., and the time required to connect the hose with the standpipe and play a stream of water upon any one of the floors is taken.

* * *

The time balls located in New York, Philadelphia, Boston and other important cities are operated at the moment when the ball falls by an electrical impulse from the naval observatory at Washington. A short time ago a time-ball apparatus was erected on the top of the Ames building at Boston, and the following description is from the *Boston Globe*.

"The time ball is 47 inches in diameter and is composed of a large number of ribs of brass covered with canvas. On the top of the Ames building is a circular shelter house containing the hoisting drum and electrical mechanism for releasing the ball. On top of this is a steel cylinder, five feet high and 50 inches in diameter, into which the ball falls when released and where it remains until hoisted the next day. The ball slides up and down upon a mast of 4-inch pipe, rising 41 feet above the shelter house. At 11.55 A. M. every day the ball is hoisted to the summit of the mast, and at exactly noon it drops. If the wires are interrupted or any other accident happens, to prevent the drop of the ball at noon, it will be lowered slowly by hand at 12.5 P. M. On Sundays and holidays the ball will not drop.

"While the electrical impulse releasing the time ball comes directly from Washington the electric current is relayed, as it were, at the electrical office of the hydrographic department, in the basement of the custom house. Here a telegraph relay and sounder have been put in, and every second is ticked out over the sounder, with the exception of the 29th, up to 11:59:49, when the ticking ceases and the attendant on duty opens the switch connecting with the magnet in the shelter house on the Ames building roof.

At precisely noon the electrical impulse comes through from Washington, operates the releasing mechanism and the time ball drops."

THE THERMIT PROCESS.

REPAIRING CASTINGS AND WELDING WITH THERMIT—A PRACTICAL PROCESS WITH GREAT POSSIBILITIES.

FRANK C. PERKINS.

The metallic mixture known as thermit was discovered by Dr. H. Goldschmidt, and is used in certain processes for obtaining intense local heat up to 3,000 degrees Centigrade (5,400 deg. F.) and at the same time producing molten iron having the qualities of a very mild steel.

Thermit is a mixture of aluminum and oxide of iron in chemical proportions and is produced by the Allgemeine Thermit Gesellschaft of Essen-Ruhr, Germany. It is used extensively abroad for welding and repairing of cast iron. At the works of the Cockerill Company, at Seraing, Belgium, thermit was used for the welding of broken cast iron roller-mill bosses, and Mr. Th. Moulan states that besides other tests of the repairs under hammer, the repaired rolls stood the changing torsion that such rolls are subjected to. The welded rolls were used for the purpose of rail production and were reversible. It has also been stated by Mr. W. Hugo, of the Aktien-Gesellschaft Phœnix-Eschweiler-Aue, that a roller-boss welded by the thermit process after rolling 198½ tons of material, broke at a point some 7 inches from the weld, and from the appearance of the fracture the break was not due to the welding process that the roller had been subjected to. This process has been employed for welding together iron tubes for use in freezing plants and overheated coils, with great satisfaction in Denmark, at the works of the Aktieselskabet "Atlas," in Copenhagen, and it has also been extensively used for welding iron tubes in the machine works and foundry of the Hallesche Maschinen Fabrik and Eisengiesserei, of Halle a/s, Germany.

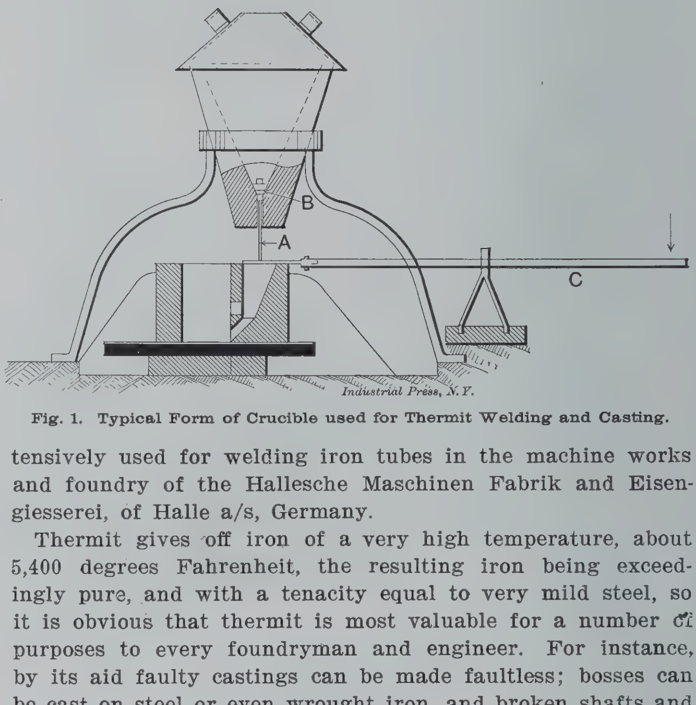


Fig. 1. Typical Form of Crucible used for Thermit Welding and Casting.

Thermit gives off iron of a very high temperature, about 5,400 degrees Fahrenheit, the resulting iron being exceedingly pure, and with a tenacity equal to very mild steel, so it is obvious that thermit is most valuable for a number of purposes to every foundryman and engineer. For instance, by its aid faulty castings can be made faultless; bosses can be cast on steel or even wrought iron, and broken shafts and wheels repaired. The thermit iron has the property of melting the cold surfaces of the metal it touches, and uniting with it to form one solid mass. Thermit iron produced in a special crucible remains at the bottom of it, and is covered by a layer of three times its bulk of slag. There are two methods of extracting the molten iron out of the thermit, after the reaction has taken place. Either the slag can be poured off first, or the iron can more easily be let off first by an opening in the bottom of the crucible, which opening must not exceed a certain diameter. The crucibles are of varying size, to contain from about 2 pounds up to 200 pounds of thermit, and even more. The whole bulk of thermit is put into the crucible at the same time, and is set alight by adding a thimbleful of ignition powder, and applying a fuse. The whole contents melt down within a few seconds. The

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A brief description of the Thermit process, published in MACHINERY some time ago, previous to its introduction in this country, aroused considerable interest among our readers and led to numerous inquiries. We are glad, therefore, to be able to give so complete an account of this interesting development in thermo-chemistry in this number.—EDITOR.

opening at the bottom of the crucible is closed by a small round piece of sheet iron of the size of a dollar, on which is pressed about ½ inch of fine dry sand. When the reaction is complete, the sheet iron plug is driven up by a pin placed in such a position below it that, although it does not touch the plug, it can easily be forced up by a simple lever. The thermit iron issuing from the bottom of the crucible flows into a runner in the mold in such a manner as to rise up again in the mold. The slag which follows can be diverted through an opening, arranged at the side of the runner, at a point about the highest level desired in the castings.

The thermit iron has such a high temperature that a certain proportion of iron punchings, free from grease, can be mixed with the thermit which still retains its property of attaching itself to the metal with which it comes in contact. The quality of iron punchings varies according to the quantity of thermit used. Where only a few pounds are used, no iron punchings should be added. For quantities of 10 pounds or more, the proportion of punchings may be 5 to 10 per cent. and for quantities over 25 pounds up to 15 per cent. may be added. To improve the cast, a very little, say ½ per cent. pure manganese is added, which may be mixed with the thermit, but the best way is to put it into the mold. The surface of the metal to be operated upon must, of course, be properly cleaned free from rust and grease, but not necessarily bright. It should then be warmed, just too hot to hold, or even to a dull, red heat, but never more. Iron can be joined to iron, as lead is soldered to lead. This process is called "thermiting," and is applied to girders, bars, angles, in fact any section of rolled or wrought iron, or steel. In all these cases a special mold is required.

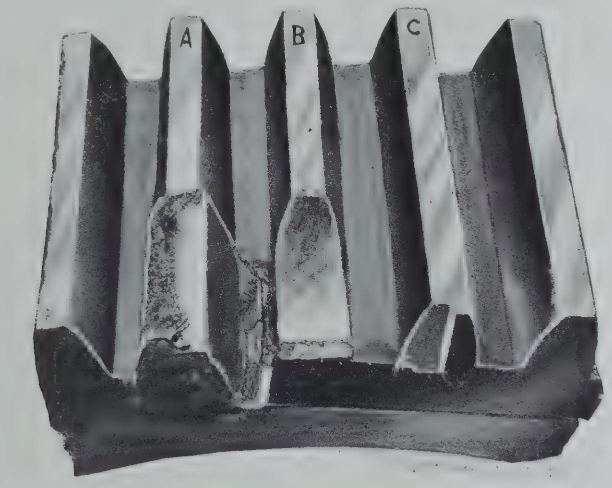

Fig. 2. Illustrating Repair to Broken Gear.

Where a mild steel casting is wanted in a hurry, it can be readily made by using thermit with 20 per cent. of small punchings or pieces of thin charcoal sheet iron added. This is run into the mold in the usual way, no furnace or cupola being required.

In welding two pieces of tubing 2 inches inside diameter and ¼ inch in thickness, two sheet-iron molds are employed to inclose the tubing with sand, in order to prevent bad results in consequence of incorrect shape. The two pipes are closely pressed together by the clamping apparatus, the mold fixed, and surrounded by fine damp sand in the surrounding sheet-iron box. Two and one-half pounds of thermit are then measured out, ignited as directed above and the contents of the crucible quickly poured into the mold directly after the surface is free from floating black particles. After about 1¼ minutes the clamps are tightened and the welding is effected.

Pipes of even thickness are most suitable for being welded. Pipes showing differences in thickness of 1-16 inch or even 1-32 inch cannot be operated upon by the thermit process without special precautions being adopted to get an even heat on both sides, which experience alone will teach.

For welding thermit iron on castings and wrought pieces, the apparatus is arranged as shown in Fig. 1, on the preceding page. The small iron pin *A* must be cut down to the required length, the asbestos washer and the small round iron plate *B* placed in position, and the tap-hole well covered up by a thin layer of magnesia, which must be pressed down a little. After this, the manganese, and then the thermit are poured into the crucible, then a thimbleful of ignition powder is thrown in a little heap on the thermit, which is ignited by means of an ordinary fuse. As soon as the reaction is complete, the handle of the lever *C* is pressed down, which will lift the pin in the tap-hole and allow the molten mass to flow out—first the iron, and then the corundum (or slag).

It is said to be advisable to let the welded pieces cool down gradually, and to warm large pieces, before the operation is commenced.

The accompanying illustration, Fig. 2, shows a section of a gear wheel, showing one tooth *C*, on the right repaired and machined, another in the center *B*, broken ready to be mended, and a third on the left *A*, mended but not machined. These teeth are 2½ inches in depth and 6 inches long. It is stated that demonstration on the use of thermit will be made in this country soon for both the welding of rails and tubes, as well as the repairing of castings.*

On electric railways various methods of bonding rails are used for obtaining a good return conductor through the track, as it is desirable to secure such complete and permanent electric continuity as to prevent the leakage and loss of current which often creates great damage to water and gas pipes by electrolysis. In addition to obtaining good electrical contact between the rails, it is also desirable that the joints be nearly perfect in order that the car will not be jarred as the wheels pass over the joints. Electric welding has been extensively used with great success, and produces a perfect joint between the rails, although somewhat expensive. The welding of rails of trolley lines by means of thermit has been quite extensive in Germany and will without doubt be introduced in England and in this country at an early date. Thermit is a metallic mixture of aluminum and oxide of iron in chemical proportions, as mentioned above, and its action is particularly well adapted to welding of rails.

Director Paul Clauss, of the Dresdener Strassenbahn, has stated that the total number of welds made on one kilometer of tramway in Hechtstrasse, only about 1 per cent. of the actual welds were broken, and he states that the welds are harder and not softer than the adjoining iron, while the time required for making the weld between the rails is not longer than that of fixing an ordinary fish-plate.

The thermit welding process has also been employed by the Strassen-Eisenbahn-Gesellschaft of Brunswick, and Mr. Herkt. Lichtenberg states that the cars which are of the accumulator type, weighing each 7 tons, operate upon the welded road without the slightest jolting, and that the welding has been utilized to advantage upon two of their lines—one a quarter of a mile, and the other half a mile in length—the first track being laid upon macadam foundation with ordinary pavement; and the second track on a cement foundation with asphalt pavement.

There are two ways of emptying the crucible; one by pouring out from the top, the second by drawing off from the bottom. In the first case, the slag flows out before the iron; in the second, the iron before the slag. The nature of the application determines which of these methods has to be adopted:

1. Pouring the Slag First.—The slag cooling far more rapidly than the iron, deposits a thin layer on the object it touches, which is thus protected from contact with the molten thermit iron that follows. The latter can, therefore, be applied to hollow iron objects without melting them through or adhering to them. It is especially useful for welding wrought iron or steel pipes, which, on account of the simplicity of the process, can be done in place. All that is required is to clean the welding surfaces, place a mold round the joint, and pour the contents of the crucible. In this way some 50,000 joints of all sizes have been made in the last few months. The weld once made requires no repairs, and stands as high a pressure as the pipe itself. Angle irons and bars of other

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* These demonstrations have been made since the first portion of this article was written.—EDITOR.

sections can be equally welded in this way, the result being a clean butt weld.

2. Tapping the Thermit Iron First.—The chief merit of this application is that the thermit iron flows out at such a high temperature that it melts the surfaces of the metal it comes in contact with and amalgamates with it, so as to form one homogeneous mass of mild steel. It has, therefore, been largely used for welding tram rails, repairing faulty castings up to any size, and many other purposes which will at once occur to any engineer. In this case the metal is drawn off through a small opening in the bottom of the crucible provided for that purpose. When the reaction is complete, merely pressing a lever forces up a plug, which allows the metal to flow out; the slag follows. The molten thermit iron round the joint can be of any desired thickness, and in the case of rails takes the place of sole plate and fish plates, with this difference, that it is welded on.

3. For Some Purposes no Crucible is Required.—For example, where a large roller boss is broken off, the roll is placed on end, a mold formed above it, about ½ inch of molten iron is poured onto the broken surface, and thermit added at the rate of about 30 pounds to the superficial foot. It is ignited with the help of ignition powder, except in the case of hot liquid steel, the best of which is in itself sufficient to effect the ignition. Cast iron or steel in sufficient quantities to form the new boss are then added and well stirred. Cast iron can be united with steel, and steel with cast iron.

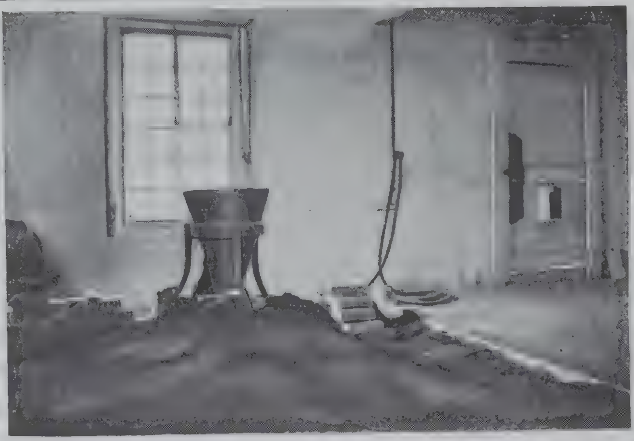


Fig. 3. The Crucible and Mold ready for Butt-welding Steel Rails.

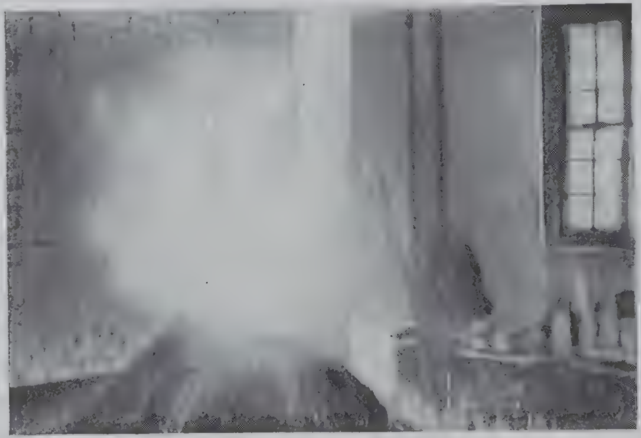


Fig. 4. The reaction during which Alumina Oxide and Thermit Metal are produced.

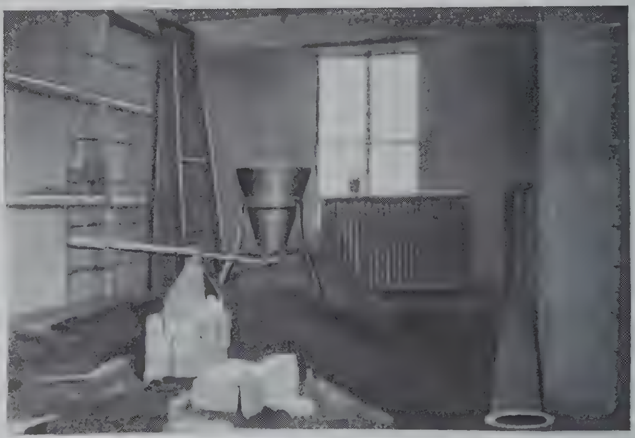


Fig. 5. Another View of the Crucible showing the Tripping Lever.

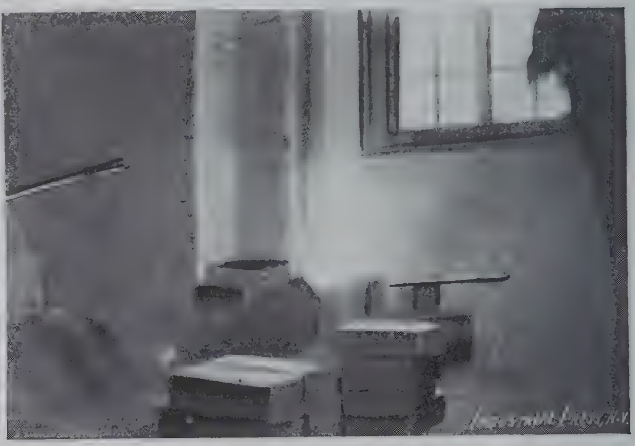


Fig. 6. Reaction in an open Crucible for Top Pouring.

The process is also used to superheat, as well as to render extremely fluid, both steel and cast iron by adding between 1 and 6 per cent. of thermit, according to requirements.

In addition to thermit as described above, Dr. Goldschmidt has found that specially advantageous results can be obtained by a combination called "Titan thermit." This is added to cast iron in the ladle, where extra tough, fine-grained iron for cylinders, etc., or malleable iron is required. It also tends to increase the fluidity of the run. The quantity required varies from 0.25 to 1 per cent. The process has also the advantage of producing certain metals for alloys in a very pure state and free from carbon. So far this has not been possible even in an electric furnace. The most important of these are chromium and manganese. The former is largely used by gun, ammunition, armor plate and tool steel manufacturers; the latter, especially for copper, tin and zinc alloys (besides nickel and britannia metal). The usual proportions of added manganese for bronze and nickel is 2 per cent.

The production of corundum is, finally, another branch of the process. It is known as "corubin," and is a peculiarly hard and sharp form of emery, the applications of which are numerous and well known.

Demonstration of Thermit Process in America.

The accompanying illustrations, Figs. 3, 4, 5 and 6, show the apparatus used in a recent demonstration of the thermit welding process at the hydraulic works of Henry R. Worthington, in South Brooklyn. The demonstration was under the direction of Clarence B. Schultz, American representative of the Allgemeine Thermit Gesellschaft. The crucible used in welding of rails noted in Fig. 3 was filled with about 16 pounds of thermit and a small quantity of superoxide of barium placed on the top and started with a match. Immediately the most marvelous chemical reaction (Fig. 4) took place, raising the mass to a white heat, the aluminum slag floating upon the thermit iron. The iron was tapped off from the bottom, passing into the mold below and melting the steel rails at the joint, forming a perfect weld.

It is said that the uniting of the aluminum with the oxygen of the oxide of iron is so terrific that for every kilogram of thermit 1,270 horse power in heat is developed or about 10,000 horse power in the welding of the two rails.

The smaller crucibles were used for the reduction of manganese, as well as for the welding of two-inch iron tubes. The welding being practically perfect, a small quantity of thermit was started as mentioned above, the barium acting in a similar way to magnesium or flash light powder for starting the chemical reaction. Instead of running the metal first from the bottom of the crucible as in welding the rail above mentioned, the slag was poured into the mold first from the top of the crucible, thus coating and protecting the iron tubes to be welded from the fierce heat of the liquid thermit iron, by the slag. When the proper time had elapsed the tubes were compressed a trifle by the screws, and after the mold was removed the aluminum slag and thermit iron were easily knocked off, leaving a most beautiful weld, the junction being noted only by a single fine line about the tube. Continuous hammering and bending of this tube when cold only produced cracks and breaks at other points than at the weld which was the strongest portion of the tube.

The manufacture of manganese from manganese thermit was also demonstrated, and the repairing of castings by this process is most interesting.

* * *

THE USE OF THERMIT FOR REPAIRING.

To supplement Mr. Perkins' interesting article on thermit, we have secured, through the courtesy of Mr. C. B. Schultz, three photographs just received from Europe, showing two heavy marine repair jobs recently made there, by its use. One was the mending of a broken rudder quadrant of the steamer *Assyria*, Hamburg-American line; the other, a broken crankshaft of a sidewheel steamer plying on the river Rhine.

The steamer *Assyria* arrived at her dock in Hamburg in the evening of November 27, 1902, with her rudder quadrant arm cracked about four-fifths of the way through. Notice of the damage had been telegraphed ahead so that a mold could be prepared at once from the blueprints of the steamer's steering gear. That night the arm was chipped out along the crack so as to make a channel or fissure about ¾ inch wide to the full depth of the crack. The opening thus made, was to allow sufficient body of the thermit to penetrate to the opposing faces to effect a perfect weld, the thermit metal remaining in place and acting as a connecting link between the two parts. The section of the arm at the break was about 4¾ by 8¼ inches. The next morning the arm was warmed up by means of two Bunsen gas burners, to a moderate temperature, and then the mold, which had been prepared beforehand and thoroughly dried, was fitted in place. Where it fitted the arm, the line of juncture was closely luted with clay all around. The quadrant was, of course, supported so as to prevent deflection when heated by the thermit, but it was not removed from the rudder stem, nor was any other heavy part of the steering gear dismantled.

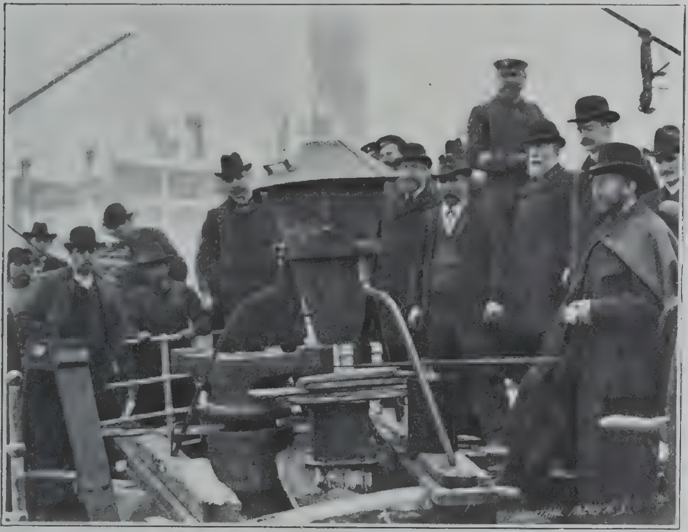


Fig. 1. Set-up of the Crucible and Mold for removing Broken Rudder Quadrant of the "Assyria."

At 12 o'clock everything was ready and the thermit was set off in the cone-shaped crucible shown in Figs. 1 and 2. The crucible was set somewhat higher over the mold than usual, in order to clear the crosshead on the rudder stem. Fig. 2 shows the thermit metal running into the mold. At 1.30 the mold was removed, revealing a perfect job in every particular. At 2 o'clock the steamer was ready to sail. The amount of thermit used for this repair was about 200 pounds.

The repair job shown in Fig. 3 was accomplished about two weeks before the repair to the *Assyria*. The crankshaft of one of the large Rhine sidewheel steamers belonging to the firm of Schurmann Sohne in Ruhrort, was cracked close to the crank. The shaft at this point is about 13¾ inches in diameter and was cracked nearly one-half way through. In this case, also, the metal was chipped out at night, making a fissure about 1⅛ inches wide for the entrance of the thermit between the two faces of the crack. The mold had been prepared beforehand from a hand sketch so that it was all ready when the channel had been chipped out. The shaft was tightened down in its bearings and propped up, to prevent deflection and imperfect alignment. The next morning a ring of thermit 2 inches by 4 inches was cast around the shaft, making a perfect union of the parts, the time required for the actual operation being about one minute. The steamer went on her regular trip the same day the shaft was repaired, without experiencing any trouble from hot bearings or other causes. The photograph showing the repaired shaft, was taken after the steamer had made several trips up and down the Rhine. About 290 pounds of thermit were used in this case.

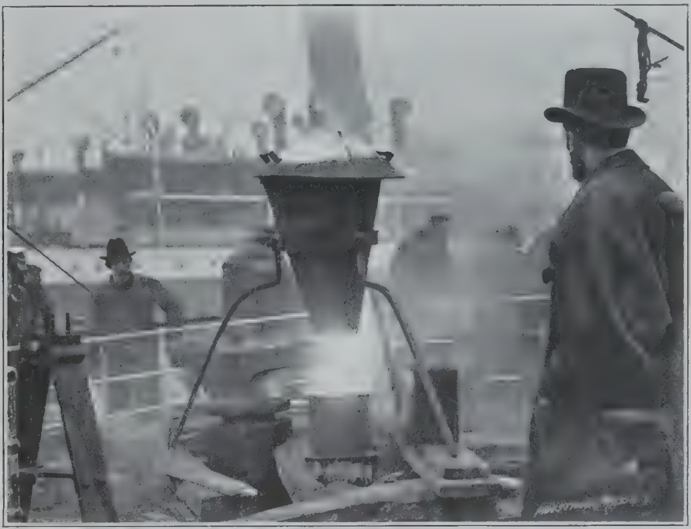


Fig. 2. Pouring the Thermit into the Mold.

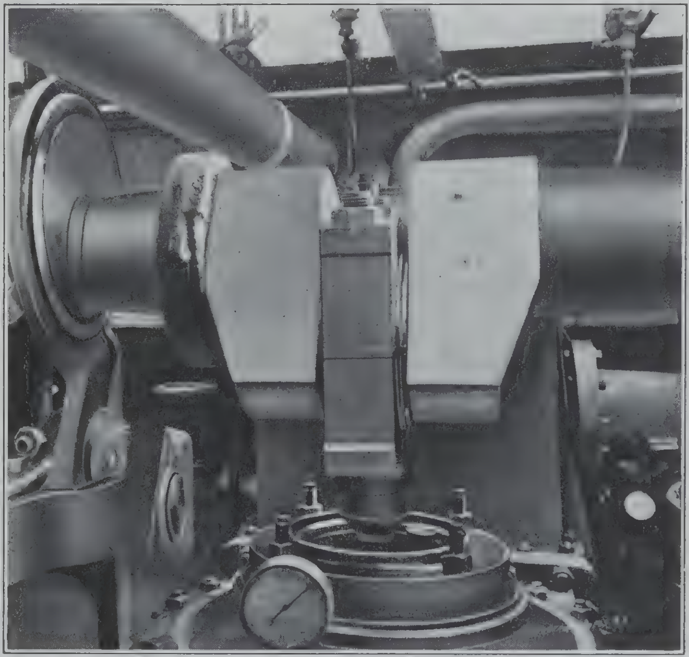


Fig. 3. Broken Crankshaft 13 3-4 inches diameter Repaired by Thermit. The Ring at the left of the Crank is the Thermit Metal.

On this side of the Atlantic Mr. Schultz has made some demonstrations of thermit possibilities, as mentioned in Mr. Perkins' article. Since welding the rail at the Worthington works, etc., he has successfully filled three bad blow-holes in the low-pressure cylinder of a large steam pump. This cylinder, having a diameter of bore of 46 inches and a stroke of about 40 inches and weighing something like five tons, revealed three blow-holes communicating between the bore and the steam port, after the first boring chip had progressed a short distance from the end. Two of the holes were approximately circular and fully 4 inches diameter. The other hole was perhaps 1½ inches wide and 7 inches long, with nearly a right angle bend at the center. On account of the location of the casting and some other considerations, the holes were repaired successively on different days, one heat being made for each. From a superficial examination made by the writer after all the holes were repaired, the job appeared perfect so far as solidity and tightness were concerned. The molder who was in attendance, had had considerable experience in repairing broken and defective castings by "burning on." He said that it would have been impossible to have repaired this job successfully by burning because of the location of the defect. The chances were that even if a perfect union was effected, the cylinder would have cracked from unequal expansion. Thermit is so quick in its action that expansion strains are largely avoided.

The cylinder was prepared by thoroughly cleaning out the holes so that no dirt, scale, or grease should be present and was locally warmed by the application of two red-hot pieces of iron weighing perhaps 40 pounds apiece, which were allowed to remain long enough to raise the temperature around the holes to, say, 200 degrees. The warming-up process is to prevent the thermit chilling on first contact and preventing a perfect union. Over the hole was set a small cast iron flask containing a thoroughly dried open mold somewhat larger than the hole, and a gate communicating with the bottom. The mold was luted around the edge with clay so as to prevent escape of the molten metal.

The operation of setting off the thermit is simple, i. e., merely igniting the superoxide of barium powder with a match, the sheet iron cover being removed for the purpose. The cover, which is then replaced, has a hole in the center to allow the escape of the gases, and to allow the reaction to be watched, which must be done through the medium of colored glasses. After the reaction has reached the critical point as determined by the sound emitted, the tripping lever is forced upward and to one side, allowing the metal to flow into the mold. In this case as soon as the metal had chilled sufficiently, the mold was pulled off out of the way and the metal pounded down with a hammer to close up the surface and to remove some of the superfluous portion projecting above the bore.

* * *

WESTINGHOUSE ON AMERICAN METHODS.

On the night of January 9th, at Claridge's Hotel in London, George Westinghouse entertained at dinner a large company of British railway managers, financiers and scientists, among the latter being Lord Kelvin. In response to a toast proposed by Lord Kelvin (formerly Sir William Thompson), Mr. Westinghouse made a speech in which he spoke at length on American methods. He referred first to the difficulties he encountered in the early days of the airbrake when it was being introduced in England. He had much difficulty in getting the English railway managers to discard the wooden brake shoes then used and substitute cast iron shoes instead. In speaking of American methods he explained that the scarcity of labor in America had been largely responsible for the wonderful progress made in labor-saving appliances, and in this connection he said in part:

"In America, however, we have always been short-handed with regard to labor. We have been obliged to find methods whereby one man may accomplish the work of two or three men as compared with your practice here. We have had the best men from Europe: Englishmen, Germans, French, everybody—skilled men, highly trained men, as well as laboring men; we have combined their experience with our own, coupled it with our necessities, and have thus accomplished results unattainable in a country like this where you have more labor than you can well keep employed.

As an illustration of what has been accomplished by the use of electricity in a great industry, I may cite the Homestead Mills of the Carnegie Company. Mr. Schwab, whose name is well known to you, is a genius in his way, particularly in the management of men; he is a master in organizing and directing men. Mr. Carnegie believed in him, and if Mr. Schwab made a suggestion in regard to the use of new appliances, even if it involved the tearing down of an old mill and putting up a new one, the new one was ordered. What Mr. Schwab thought should be done, was done. As a result of such progressiveness, we may see the splendid mills at Homestead where they produce with about 4,000 men three times as much steel as the Krupp works produce with 15,000 men. The results are simply wonderful. You can start there to-day, in a building containing steel-melting furnaces, and you will there see three men mounted on a car with the charging apparatus which is moved and operated by electricity. With a few movements of this ingenious contrivance three men charge twenty furnaces, which, prior to the use of electricity, would have required the labor of over 200 men.

"You may go into the yard of the Homestead Mills where they pile the metal in stock. This yard is covered by a system of overhead cranes, and the result is that not only here, but in the mill, and in every other place, you may see great weights lifted and many undertakings going on without a single man exerting himself a bit—working not half as hard as I am working now. (Laughter).

"I took some English friends to Homestead. Mr. Schwab, after guiding us through several departments, said: 'I will now show you where we turn out 750 tons of plate girders per day.' The mill was in the shape of an 'L.' We went into the short end of the 'L' where the furnaces were fed by natural gas, of course requiring no stokers. The end at which we entered had a rather low roof, and there was in sight a contrivance like a battering ram in front of the furnaces; two workmen were sitting down eating their dinners near by; no one else was present. I thought: 'Mr. Schwab has made a mistake; he has asked us to see a mill that is not in operation.' But we went through the mill, which was about 200 feet long; and suddenly we heard a rattle and then saw a truck approaching, loaded with a big ingot. No one touched the truck or the ingot. The load came to a platform, the crane overhead dropped a pair of tongs and quickly put the ingot on the roller table, and as it moved along to the great rolls, it was automatically kept in place. The adjusting screws of the rolls were turned by little electric motors, and not a man in that house did a bit of work. It was just as easy as what you are doing now—looking on! (Laughter). We went back to the furnaces. There was a fifteen-year-old boy seated in a little place called the 'pulpit.' He was able, merely by the movement of levers, to open at will any of the furnace doors and move the car along. And we saw this car come in front of a furnace and the charging machine approach, and take out of the open furnace a hot ingot which was dropped on the car and moved off to its work. There was this boy doing absolutely no hard work, and his mill was turning out 750 tons of steel plate each day. My English friends said: 'England has no chance in competition with such methods.'

"Now all this sort of thing came about in America because of our necessities. We hadn't men enough to do our work. There was a premium in favor of those who could invent machines to work and thus supply the deficiency.

"At the Carnegie Mills we went to see three blast furnaces. They were making 1,800 tons of pig iron in twenty-four hours. We saw only two or three men on a truck which was moved automatically. These men were letting the ore run from chutes and mixing it in the required quantity, and when they had filled a truck, it was carried up and its contents dumped into a furnace whence it returned for another load. They were running the metal into an immense receptacle into which the metal from all three furnaces was mixed. From this place the metal was taken as required, put into a special tank, mounted on a car and taken to Homestead, two or three miles away, to be poured into the furnaces; one heating only was required."

* * *

On January 29 the Empire State Express, on the New York Central, established a new speed record. It covered the distance from Palmyra to Macedon, N. Y., 7.29 miles, in four minutes, or at the rate of 109 miles an hour.

SHOP CONSTRUCTION.—6.

HEATING THE BUILDINGS.

OSCAR E. PERRIGO.

The construction of our several buildings being now completed and all arranged with proper consideration of the existing conditions and the expected circumstances by which we shall be governed, it is necessary that we should arrange for their proper and efficient heating and lighting. In this article the first of these questions, that of heating, will be considered.

There are many systems of heating buildings, among which are: By means of exhaust steam or of live steam, in lines of pipe arranged overhead or along the walls; by coils or radiators; by hot water utilized in a similar way; by air heated by furnace arrangements or by contact with pipes through which steam flows. All these systems have their good and bad features, both as to their warming qualities and their cost, as well as the expense of operating them. The hundreds of feet of steam pipes, with their numerous fittings, furnish so many opportunities for leaks, and special arrangements must be made to keep them clear of water. The distance from the boiler to the further end of long systems frequently requires much time to force enough steam to these points to warm the rooms so that they will be endurable to workmen. The hot water system works slowly and the temperature of the surrounding air rises gradually, so that the hour for beginning work in the morning must be anticipated by such a length of time as to be a serious drawback to complete success. The hot-air furnace gives air from which much of the moisture is evaporated and which is therefore unwholesome, aside from the fine dust so often brought along with it. In all these systems heating is the only end gained, ventilation being left largely to chance.

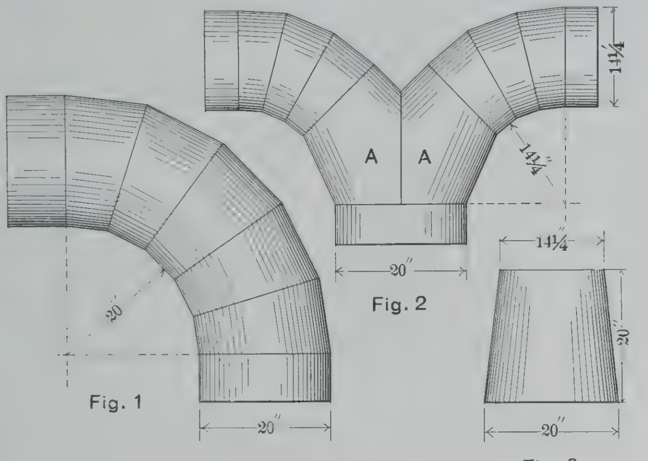


Fig. 1

Fig. 2

Fig. 3

Industrial Press, N.Y.

Elbow and Divided Pipes.

The ideal system of warming and ventilation would seem to be that in which fresh air, warmed by steam heat, is distributed by a suitable mechanical process, as evenly as possible to every part of the building, in which this can be done in the shortest time (as in most shops the heat is not maintained during the night except at sufficient temperature to prevent freezing of water pipes, etc.), and in which cold air may be readily introduced whenever needed. This seems to be best accomplished by drawing fresh air from without the building, passing it through a heating apparatus consisting of an iron case containing a large number of steam pipes, and, by means of a fan and suitable pipes, distributing this warmed air to every part of the building by numerous outlets. The whole should be controlled by proper dampers, by which a due proportion of warm and cold air may be furnished as needed, so that proper ventilation as well as warming may always be maintained.

In the warming of such large buildings as those under consideration it is not necessary to draw cold air from the outside atmosphere to any great extent. The number of cubic feet of air contained in the building is largely in excess of that required for each person; and, moreover, cold air comes in through frequently opening large doors, while the swinging windows at the roof may be opened when necessary to permit the vitiated air to pass out, thus providing ample ventilation. Many pages might be written on this subject but space permits only a few general requirements which are practically indispensable, and may be summed up as follows:

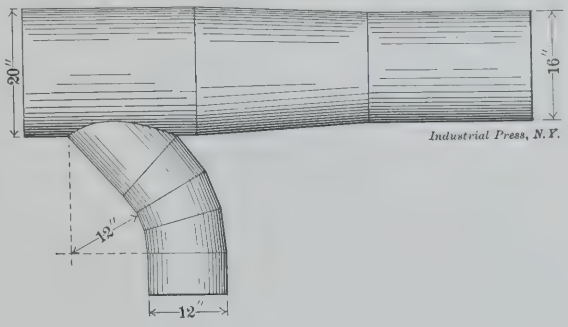
The heating apparatus should be located near the center of the building so as to distribute the warm air to all points with the least amount of piping.

Openings should be so arranged as to be not over 30 feet apart, and to open toward the outer walls of the building. They should not be less than 8 feet above the floor, nor less than 5 inches diameter, and usually incline downward at an angle of about 10 degrees. The aggregate area of openings should exceed the area of the main pipe at the fan by about 25 per cent. About 6 square inches area of openings should be allowed to every thousand cubic feet of space contained in the building—or room, where the building is so divided. The velocity of air should not be less than 1,500 feet per minute, and a sufficient quantity should be supplied to change the air every 15 to 20 minutes.

The pipes are preferably circular, as less material is required to make them of this form; furthermore, the circular pipes are stronger, and there is less friction of air in passing through them. For instance, a circular pipe 5.65 inches in diameter will have an area of 25 square inches and its circumference will be 17.88 inches. A square pipe 5 inches each way will also have an area of 25 square inches but the sum of its four sides will be 20 inches. A rectangular pipe 2 x 12.5 inches will be of equal area but the sum of its sides will be 29 inches, or about 1.6 times greater than the circular pipe.

Nevertheless it often happens that square or rectangular pipes are necessary, on account of lack of space. When such is the case this area of cross-section must be increased accordingly, so as to avoid undue friction. Galvanized iron is the most desirable material for these pipes and is almost universally used where pipes separate from the building construction are employed. In factory buildings having several floors, proper flues and air ducts are arranged in the walls, and in the basement, where the heating apparatus is usually located.

In constructing pipes several important rules must be observed. In making a change of direction of 90 degrees the elbows should be made of not less than five pieces, and the radius of the inside of the bend should not be less than the diameter of the pipe, as shown in Fig. 1.



Industrial Press, N.Y.

Fig. 4. Branch leading from Main Pipe.

Where a main pipe is divided, the construction should be as shown in Fig. 2, the pieces *A A* being the frustum of a cone whose diameter at the base and whose height are equal to the diameter of the main pipe, and whose smaller end is equal to the diameter of the branch pipe, as shown in Fig. 3. This pipe is then cut to the proper form to fit its counterpart, as shown in Fig. 2.

Where branches are taken off from a main or leading pipe they should be so arranged as to leave the larger pipe at an angle of not over 45 degrees, and the inside radius should be not less than their diameter, as shown in Fig. 4. The contraction of the leading pipe, due to the taking off of this branch should be made by the next sheet, the sheets being usually 30 inches wide. This reduction of area should not be quite as much as the area of the branch pipe. The further the air travels from the fan, the less force it has, and this should be compensated for, as far as may be, by slight allowances in area as the various branches are taken off, bearing in mind that this allowance should finally lead up to 25 per cent. excess of outlet areas over the area of the main pipe at the fan.

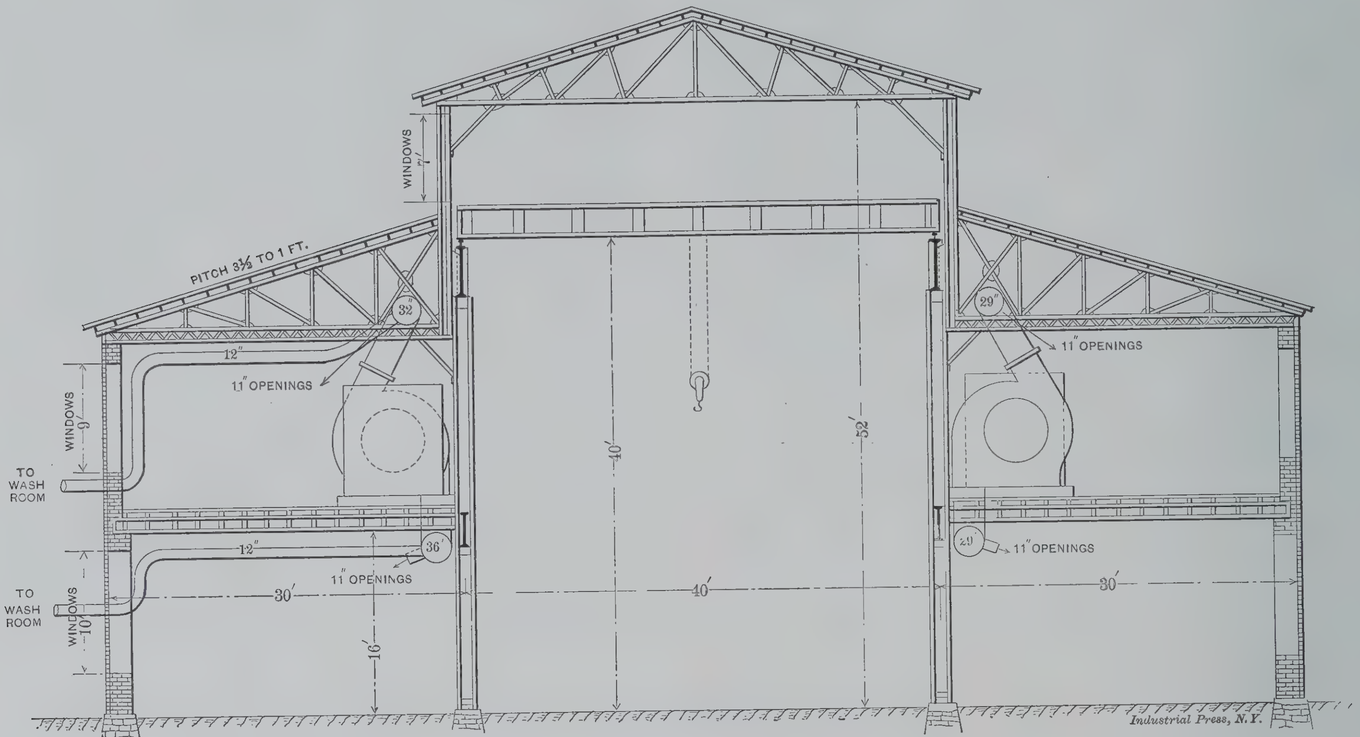


Fig. 5. Cross Section through Machine Shop.

In offices and comparatively small rooms the outlets are usually in the form of rectangular registers placed in the side walls near the ceiling. The area of these should be from two to three times the area of the pipe leading to them.

Fig. 7 shows the plan of the arrangement of the heating system of the machine shop and Fig. 5 a cross-section of the same, giving the diameters of the pipes at various distances from the heaters; and the number, direction, diameter and location of the openings, not only for the machine shop proper but for the carpenter shop, wash rooms, etc.

The heating apparatus consists of a rectangular iron case containing a large number of steam pipes of practically U-shaped form, inverted and connected to a cast-iron base in such a manner that one leg of the pipe connects with the space through which the steam is admitted and the other leg connects with the space from which the drip is taken. These pipes should be located as close to each other as practicable, the rows of pipes being set "staggering" so as to break up the currents of air; and the casing which surrounds them and connects with the inlet of the fan should also be formed as closely to the pipes as may be, in order that all air which is drawn through may come into close contact with the heating surfaces of the pipes.

It is customary to allow one foot of 1-inch pipe, or its equivalent, to each 100 to 150 cubic feet of contents of the building to be heated, when all the air is taken from out-of-doors. In the case under consideration with one-half or more of the air from within the building the higher figure would probably be ample. At the end opposite the fan are located dampers for regulating the amount of air supply. One of these may be connected with a cold-air duct from out-of-doors, where necessary.

Referring to Figs. 5 and 7 the location of the apparatus is seen to be in the gallery floor, near the center of the building. The fan has two discharge openings, one downward for warming the side wings of the first floor, and one at an upward angle for the same service on the gallery floor. The returning currents of air flow into the central portion of the building and warm that portion in their upward course.

Two sets of apparatus are used, for the reason that the traveling crane over the central portion of the shop prevents convenient connections between the two sides; and further, that the space to be heated is so large that the questions of convenience and economy are best met by this arrangement. The apparatus on the side nearest the power house will require a fan with a wheel, say 100 inches diameter by 52 inches wide, and running at about 185 revolutions per minute.

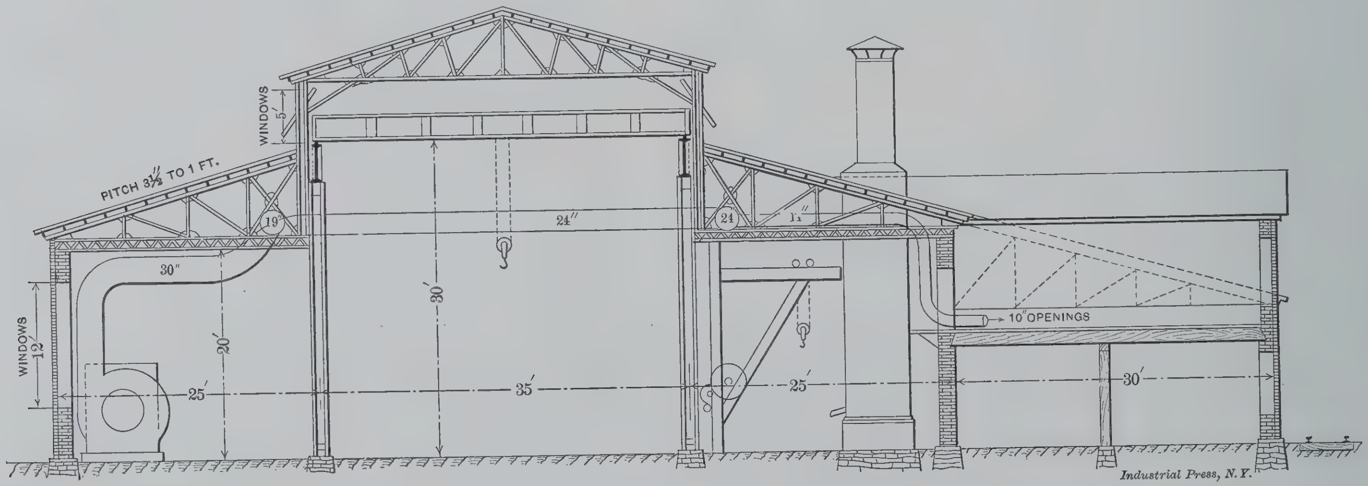


Fig. 6. Cross Section through Foundry, Cupola Platforms, Etc.

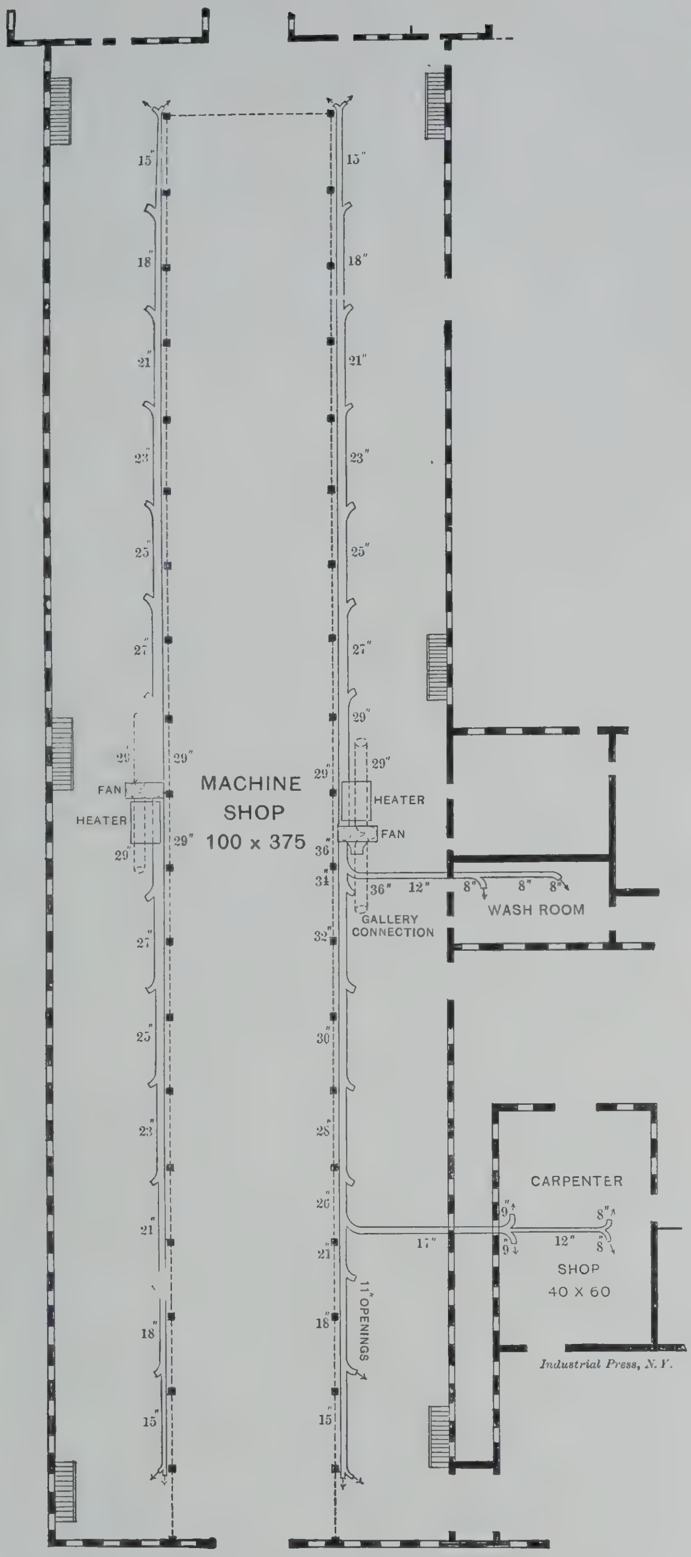


Fig. 7. Heating System for Machine Shop.

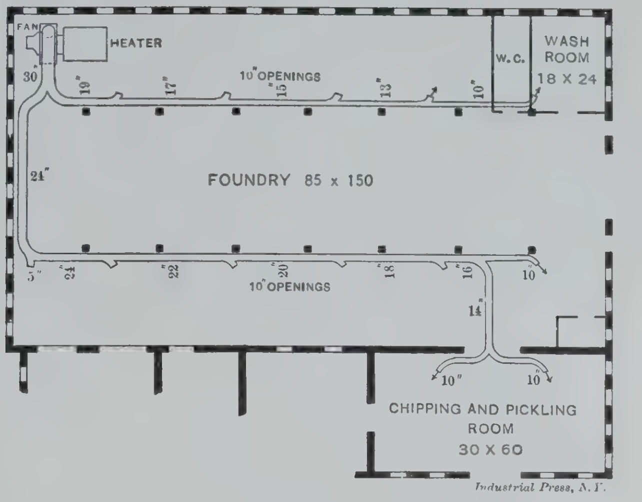


Fig. 8. Heating System for Foundry.

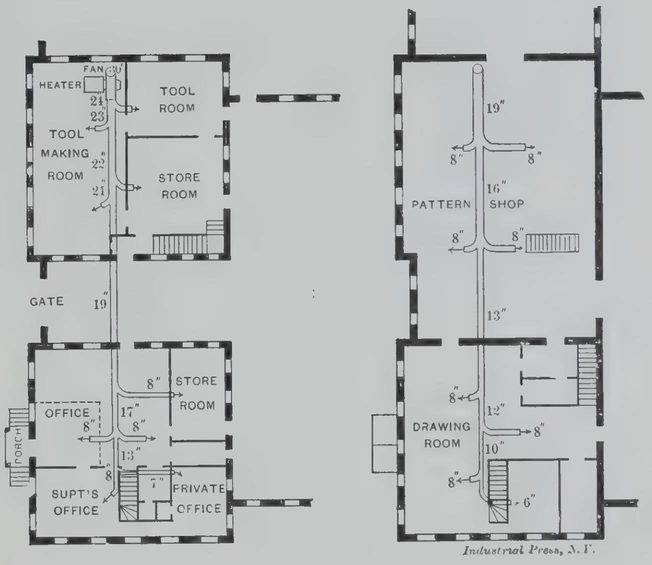


Fig. 9. Heating System for Offices, Etc.

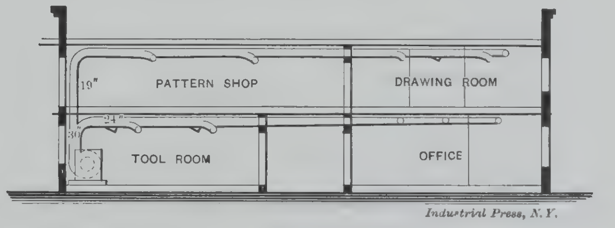


Fig. 8. Longitudinal Section through Offices, Etc.

This will supply from its downward opening the pipes for the main floor, including that leading to the carpenter shop and to the wash room on the first floor; and from its upward opening it supplies the pipes from the gallery floor, including one for the wash room on the second floor. The apparatus on the opposite side of the shop should have a fan with a wheel, say 90 inches diameter by 48 inches wide, running at about 205 revolutions per minute. The pipe connections are similar to the first apparatus, except that there are no long branch pipes to be provided for. Hence, while a 36-inch pipe is necessary for the side toward the power house, in order to warm the carpenter shop and the wash rooms, one of 29 inches diameter will be quite sufficient for the opposite side. It should be said that the dimensions given on the drawings are from actual calculations, taking into consideration all the circumstances of the form and dimensions of the buildings, and they will probably be found correct in practice as in theory.

The openings for the discharge of warm air into the building are directed toward the outer walls and downward at an inclination of about ten degrees. This arrangement is clearly shown in the drawings, Figs. 5 and 7.

The pipes should be well riveted as they are put up and securely fastened so that they may not be loosened by any jarring or vibration, either of the building, or that caused by the pressure of air passing through them.

The fans may be driven by an electric motor or by an engine attached to each fan; or, if preferred, by belts from the main line of shafting. Any of the these methods is efficient and has its particular advantages. If an engine is used, the large fan will require it to be of about 27 horse power and that for the other fan should be of about 20 horse power.

Live steam being used for heating, the large apparatus will probably require a supply pipe of 6 inches in diameter and the smaller one of 5 inches. The apparatus should be so constructed that a section of it may be separately connected for using the exhaust steam from the fan engine. In the same way the exhaust from the main engines of the works may be utilized and thus save a considerable portion of the live steam required. In arranging for heating the foundry, different conditions are met with. With the exception of the chipping and pickling room heat is required hardly more than half the time, that is, during the forenoon, and perhaps for an hour or more after the dinner hour, as the heat from the cupolas is considerable.

The general plan of the system is the same as that employed in the machine shop. The apparatus requires but little room on the floor and consists of a fan having a wheel about 78 inches in diameter and 24 inches wide, running at about 400 revolutions per minute and will require about 6 horse power to drive it.

An arrangement of pipes can, of course, be made whereby the chipping and pickling room could be warmed independently of the foundry proper, but it would probably not be necessary. Figs. 6 and 8 show the arrangement of the foundry system of heating, with diameters of the pipes and openings. It will be preferable to run this fan by an electric motor or a small engine and since these fan blowers for heating purposes are now made with simple and compact engines attached to them, which require very little attention, aside from starting, stopping and oiling up, they are very convenient in such situations. It is always important to have the heater as near the space to be warmed as possible.

The office building, including the pattern shop, drawing room and tool department, is heated by an apparatus located in the tool room and forming a separate system. Fig. 9 gives plans of the first and second floors and Fig. 10 a longitudinal section through the building. A heating apparatus of the same size and capacity as that used in the foundry is employed. It may be driven by a separate engine, or a motor, or belted from the shaft which drives the machines in the tool room. This latter plan is probably the best, since the power is convenient, and the first cost may be lessened without sacrificing any desirable feature in another direction.

The system of piping is clearly shown in the illustration and needs little explanation. The main pipe passing through over the driveway must be amply protected, preferably by being encased in a wooden box several inches larger than itself, the space being filled with sawdust or similar material; and this again is covered by another box large enough to leave an air space of about 3 inches between the two, on all sides.

For the office rooms the pipes may be of rectangular form, concealed by suitable architectural finish of the ceiling, in which lateral openings for registers may be made. Or, proper air ducts may be formed in the side walls and the registers placed at suitable intervals. Or, again, the pipes may be carried around inside the walls, close to the ceilings, and registers located in the same manner. There may be for this system the double-duct arrangement. That is, two sets of pipes or ducts, one carrying cold and one warm air, the registers being so arranged that they will furnish one or the other, or a mixture of both, by means of what is technically known as a "mixing damper."

In offices and rooms of moderate size which are heated by warm air being forced into them near the ceiling, it is usual to provide means of escape for the air as it cools and descends to the floor, through grated openings placed two or three feet from the floor, and connected with flues or ducts leading to the roof. But in offices where doors are frequently opened this does not seem to be necessary, the matter of ventilation being of small consequence compared to that of heating.

The forge shop and various other buildings require no special arrangements for heating. The water closet rooms may be warmed sufficiently by providing grated openings in the wall dividing them from the boiler room. They should be near the ceiling, on each floor.

The question of proper temperature of shops where men are at active work should be considered as quite different from providing for heating a factory where the work it usually much lighter, the number of employees per hundred feet of floor space much greater, and frequently a large proportion of them females. In a machine shop devoted to a medium class of work, a temperature of about 60 degrees will be found generally comfortable to the majority of the men. We have known of shops where the temperature seldom went above 50 degrees in cold weather, and there was no complaint. The former figure will, however, be more satisfactory.

The temperature in the store room, tool room and pattern shop will need to be about 65 degrees and in the drawing room and offices, between this and 70 degrees. Unless the ventilation is very carefully attended to, there is more danger in having these latter rooms too warm than not warm enough, and any system of heating which does not recognize the importance of good and thorough ventilation is radically wrong in both theory and practice.

* * *

THE MANUFACTURE OF METAL-WORKING MACHINERY.

Census Bulletin No. 247 contains some interesting statistical matter, by Edward H. Sanborn, on the manufacture of metal-working machinery. He says the appearance of Ohio as the leading state in the manufacture of metal-working machinery points to one of the interesting phases of the development of this industry during the past ten years. Within this decade there has been a marked tendency toward specialization, particularly among the new establishments that have started business in recent years. Most of the older manufacturers of machine tools, whose business runs back for twenty or thirty years, produce a variety of machines, in some cases embracing nearly everything required for the equipment of a new shop. In late years, however, manufacturers starting in this branch of industry have very generally limited their operations to the production of a single type of machine, or at the most to one class embracing tools of similar types. For example, there are large establishments in which nothing is manufactured but engine lathes; other works are devoted exclusively to planers, while in others, milling machines are the specialty.

This tendency has prevailed in Cincinnati, perhaps, more than in any other city, and has been one of the characteristic features of the rapid expansion of the machine-tool industry in that city during the past ten years. During the census year there were in Cincinnati 30 establishments devoted to the manufacture of metal-working machinery, almost exclusively of the classes generally designated as machine tools, and their aggregate product amounted to $3,375,436. In seven shops engine lathes only were made, two were devoted exclusively to planers, two made milling machines only, drilling machines formed the sole product of five establishments, and in three shops shapers only were made. Several other manufacturers made two or more of these classes of tools, but for the most part the industry was very strikingly specialized. Cincinnati manufacturers made during the census year 3,924 engine lathes, out of a total of 12,089 for the entire country, or almost exactly one-third of the whole number. Out of 3,076 slotters and shapers made in the United States, 1,019, or nearly one-third, were made in Cincinnati. There were also made in the same city 816 milling machines and 1,622 drilling and boring machines.

Philadelphia is one of the largest of machinery centers; eleven establishments reported an aggregate product of metal-working machinery valued at $3,095,574. These products include a wide range of tools with less of the specialization than is characteristic of Cincinnati and other localities where the industry is of more recent growth.

Providence, R. I., ranks third in the manufacture of metal-working machinery, the product of fourteen establishments amounting, during the census year, to $2,929,141. Here, again, the industry is diversified rather than specialized. A large amount of automatic and semi-automatic machinery, such as screw machines, turret lathes, and gear cutters, and also milling machines of various types, are made in Providence, and these might be said to be the chief characteristic of the industry.

Hartford, Conn., stands next to Providence, and shows about the same features in the machine tool trade, with a wide range of products, among which automatic and semi-automatic machines might be mentioned as most significant. During the census year eleven establishments in Hartford reported the production of metal-working machinery to the value of $2,796,935.

Worcester, Mass., is another important center for the manufacture of machine tools, with much of the same specialization that is manifest in Cincinnati. Twenty-four establishments reported for the census year products aggregating $2,009,357 in value. Engine lathes are one of the specialties in Worcester, and of these 2,667 were made during the census year. These, with the 3,924 made in Cincinnati, embrace more than one-half of the entire number of engine lathes made during the census year. Drilling machines of various types, particularly small sizes, are another important item in the Worcester products, 4,552 of these having been made during the census year.

While New York and Chicago are large distributing centers for machinery of every description, they do not figure prominently in the manufacture of metal-working machinery. The five large centers of the metal-working machinery industry which have been mentioned represent about one-third of the entire output of this class of machinery. The balance of the product comes from many cities, and also from a considerable number of small towns where there is a single establishment, usually making only one type or class of machines.

* * *

THE HISTORY OF ELECTRIC RAILROADING.

In a contribution to the *Technology Quarterly* upon Long-Distance Railroading, Prof. Louis Duncan gives an historical sketch of the early development of electric railroads, from which the following is taken:

Prior to January, 1888, although experimental roads had been built and were in operation in England, Germany, and the United States, yet they were not on a commercial basis, and did not offer any advantages over the then existing traction methods. At that time a road was opened in Richmond, by the Sprague Electric Railway & Motor Company, which in all essential particulars embodied the methods now used.

Mr. Frank J. Sprague graduated from the Naval Academy in 1878. While there he paid especial attention to electricity. I remember him distinctly, as captain of my gun crew at the school. For not reporting me as often as he might, he earned an esteem which twenty-four years of close association has failed to weaken. After graduation, Mr. Sprague spent six or seven years in the service. He was ordered to special duty at the Paris Exposition of 1881, and had a tour of duty at the Torpedo School at Newport. He resigned in 1885, and with Mr. E. H. Johnson, then President of the Edison Company, formed the Sprague Electric Railway & Motor Company, the object being to develop the application of motors, more especially for traction work. An experimental car was equipped and operated on a small spur of the elevated road. In the latter part of 1886, a contract was hastily closed for the equipment of the Richmond roads, and preliminary work was begun at once; but when the actual condition of affairs was investigated, it was found to be a much more difficult problem than was at first supposed.

The railroad company had stated that the maximum grade was from 6 to 7 per cent.; in reality, there were grades as high as 10½ per cent. The tracks were badly laid in streets that were unpaved and muddy, and there were a great many curves of a very short radius. However, the work was pushed forward, and the road was formally opened in January, 1888. As I have said, all the important features of modern electric cars were contained at one time or another in this first road. Series motors were used, with a voltage of approximately 500 volts at the motor terminals. A successful under-running trolley was developed, a series-parallel control was at first used, and then for reasons which at the time were good, was discarded. A single reduction gearing was at first employed, but afterwards changed to double reduction gearing. The only important feature that did not appear at one time or another in these motors was the use of the carbon brush, which is essential to the successful operation of continuous current railroad motors; this was experimented on, but was discarded, because of the indifferent quality of the carbon used.

On the day that the road was opened, there had been a heavy frost, and mud from the streets had accumulated on the tracks and frozen, the consequence being that there was no ground circuit at times. When the current was made by getting out and pushing the cars until they struck a clean rail, the inexperienced motorman as a rule had the controllers full on, and a number of motors were burned out. The brushes consisted of pieces of brass, set very much as the carbon brushes are now set; the average life of the commutator was not more than two weeks. On the first day twenty equipments were burned out. For some months the operation of the Richmond road was attended with great difficulties. The motors were not heavy enough for the work; the brushes gave an immense amount of trouble, and the roadbed itself was not fit for heavy traffic. These difficulties were gradually eliminated, and the new roads contracted for, took advantage of the experience gained.

The development from the early Richmond experience has been in the direction of making heavier and better motors, of using carbon brushes, and a series-parallel control. The essential parts of the system are, however, adhered to.

As the economy and capacity of electric equipments increased, the city roads were pushed further into the suburbs, and finally roads were built from cities to outlying towns and between cities. This movement is now probably at its maximum; a great number of interurban and suburban roads have been built and more are under construction. The interurban railroad system is simply an extension of the city tramways. The same system is used with the few modifications necessary for the much heavier cars and the much higher speeds required outside the limits of towns.

On some of the interurban roads very handsome and heavy cars are used, fitted out very much as steam cars are, and approximately of the same size, with speeds up to as much as 60 miles per hour. In fact one road is building special cars which will attain a maximum speed of 75 miles an hour, and make a schedule speed of 60 miles an hour.

When electric roads operated within a short radius, it was the custom to have a central station where the voltage was approximately that intended for use on the cars, and to distribute directly from feed wires connected at the station and to the trolley wire. When the distances became greater, a number of stations employed "boosters" for the outlying districts, the voltage being raised at the station to such an amount that the loss of potential in the feeders would be neutralized, the voltage in the outlying districts being the same as the voltage in the station. When the radius became still greater, as in the case of interurban roads, neither of these systems was applicable, and it is the custom now to distribute, when the distances are considerable, by a high potential alternating current, which, at certain points along the line, is reduced in voltage and changed to continuous current by means of rotary converters. This continuous current has a voltage of from 500 to 600 volts, and the operation from such a sub-station is similar to the operation from an ordinary central station. The advantage of this system is that it allows a very considerable length of line to be operated from a single station, thus giving economy in the generation of the power, while it does not interfere with the direct current system of operation on the cars. The disadvantages are in the cost, the losses, and the attendance in the sub-station. If the service is frequent, the average load on the sub-stations will be fairly constant, but where the service is infrequent, then the load factor of these stations is very low. This has in a great many cases been remedied by putting storage batteries in the sub-stations and running the rotary converters at a constant load, the fluctuations being taken up by the storage battery.

* * *

With the development of wireless telegraphy, it is predicted that daily newspapers will become as common on ocean liners as in our streets and that a man in need of an ocean voyage and rest from the affairs of the world will have to retire to a "tramp" steamer.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY
DESIGN—CONSTRUCTION—OPERATION.
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
66 WEST BROADWAY, NEW YORK CITY.
CHICAGO—1462 MONADNOCK BLOCK. BOSTON—620 ATLANTIC AVE.
PHILADELPHIA—MACHINERY FLOOR, THE BOURSE.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MARCH, 1903.

NET CIRCULATION FOR FEBRUARY, 1903,—28,987 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

REMOVAL NOTICE.

The business and editorial offices of THE INDUSTRIAL PRESS have been removed to 66 West Broadway, corner of Murray Street, one block from the former location, where larger accommodations have been secured, which have been made necessary by the increasing needs of our business.

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THERMIT AND ITS POSSIBILITIES.

Within the past two years we have published two or three brief accounts regarding thermit and the wonders that have been accomplished by its use in Europe. On another page of this issue Mr. Perkins gives an extended account of thermit, and illustrates a recent demonstration made at the Worthington works in South Brooklyn. This article is supplemented by accounts of recent marine repairs made abroad, and one regarding the repair of a large defective steam pump cylinder at the Worthington works, which was made in the presence of an editorial representative. In view of the extraordinary work that is done by this strange compound, we have thought fit to give it considerable space and attention, believing the subject to be one of great general interest.

Thermit is the result of the investigations carried on principally by Hans Goldschmidt, of the well-known chemical firm, Th. Goldschmidt, Essen-Ruhr, Germany, in the interests of the Krupps, who were concerned in obtaining carbon-free chromium necessary in certain steel manufacture. It was discovered that finely-divided aluminum has the property of abstracting oxygen from some oxides including iron, chromium, and manganese oxides. All that is required when the aluminum and the oxide of iron and aluminum have been mixed in certain proportions, is that a small portion be first raised to a temperature somewhat less than that of melted steel. This is done in practice with a special powder that can be ignited with an ordinary flame. The reaction that follows is almost instantaneous. The whole is at once converted into a seething, boiling mass of pure molten iron, or more properly steel, and alumina slag, the temperature of the mass being something like 5,400 degrees Fahrenheit. So hot is it that ordinary graphite crucibles are broken down and made useless, a special crucible with highly refractory lining being necessary.

From what the writer has seen of actual work done, it appears that welds practically perfect can be made in wrought iron, cast iron and steel whether in thin sections or in large masses. One of the first uses to which thermit will probably be put on an extensive scale in this country, and the one that has attracted the most attention commercially in Europe, is the welding together of street car rails. By this process it is possible to make a perfect electrical "bond," and also make a joint that is somewhat stronger than the remainder of the rail. Rail welding, as now conducted in this country, requires the use of expensive and cumbersome electrical appliances. The process by which a mass of cast iron is poured around the joint to take the place of the ordinary fishplate and bolts requires a portable cupola and power. The thermit process is simplicity itself, and as many gangs as desired can be welding rails, without making a heavy expenditure necessary.

The alumina slag produced by the reaction simultaneously with the thermit metal, is a somewhat valuable by-product, being chemically the same as corundum—in fact, it is corundum. The slag is crushed and used the same as natural corundum for the manufacture of grinding wheels.

* * *

TRANSPORTATION IN NEW YORK.

The great problem that has confronted New York City for a number of years, and one that still plagues it, is providing ways and means for transporting its vast and rapidly growing population from their homes to places of business in the morning, and back again at night. These periods of transportation activity, are known as the "rush hours," and anyone not familiar with the conditions that then exist on the street cars, elevated railroad trains and the ferries, can scarcely conceive what they are. The elevated trains are usually crowded to the last degree, although the trains are run very closely together, the headway being from one to two or three minutes. This system, the Manhattan Elevated Railroad, has four lines running north and south known as the Second, Third, Sixth, and Ninth Avenue lines. During the Dewey celebration in 1898, it carried 805,000 passengers on the first day and 836,000 passengers on the second day; yet this record, which was made on the occasion of a great national event, was far eclipsed December 22, 1902, when 931,000 passengers were carried. At this time nothing of greater importance than the activity of shoppers just before Christmas, was going on. While it is by no means a fair comparison it gives some indication of the great increase of population within the past four years.

It is predicted, and with good grounds, that the Rapid Transit Subway that is being pushed so as to be completed at least a year before its specified date, will relieve the present condition very little. The population is increasing by such leaps and bounds that by the time the Subway is in running order, the conditions will be practically the same as at the present time. The great need is for tunnels and more bridges that will allow of more and quicker outlets to Long Island and New Jersey. While the suburban population is already great, there is opportunity for a far greater one within a radius of ten miles, if adequate transportation facilities were provided.

Bearing on this subject the statistics of New York State Railroad Commission are of interest. They show that during the fiscal year ending June 30, 1902 the surface and elevated roads of New York City carried 924,754,211 passengers paying fares. Of this number 625,547,434 were carried in Manhattan and Bronx and 299,206,777 in Brooklyn. These figures show that more than 2,500,000 passengers are carried daily on the different street and elevated roads of Greater New York. These roads have 330 miles of tracks within the city limits.

* * *

NOTES AND COMMENT.

The system of heating and ventilation described by Mr. Perrigo in his article on shop construction this month is that of the B. F. Sturtevant Company, Boston, Mass. Mr. Perrigo writes us that the system was developed from a very small beginning by Mr. Sturtevant himself, who began experiments about 1869. At that time Mr. Perrigo was a draftsman in the employ of Mr. Sturtevant and made the drawings for the first heater, composed of an outer case filled with pipes for heating air by the use of steam. The first experiment was with a drum, about 12 inches in diameter and 20 inches in length. The first plants were not for heating large buildings, but for dry-rooms for lumber.

The success attending this modest beginning encouraged Mr. Sturtevant to broaden the scope of his plans until in a few years the largest and most elaborate buildings were thoroughly warmed and ventilated, and probably better than they had ever been heated before.

Prof. Dewar says that liquid hydrogen is a colorless, transparent body having a surface tension only 1-35 that of water. It does not conduct electricity and is thought to be slightly diamagnetic, that is, it is repelled from the poles of a magnet. It is the lightest liquid known, having a density only about one-fourteenth that of water. At atmospheric pressure it boils at 422.5 degrees below zero F., and at 432.5 below zero in a partial vacuum. At this temperature the liquid soon becomes a solid, resembling frozen cream, and further exhaustion of the pressure reduces the temperature to 436 degrees below zero F., or within about 24 degrees of absolute zero. The strong condensing power of liquid hydrogen makes it a simple means of producing a high vacuum, so high indeed that the electric discharge passes through it with great difficulty.

In the automatic threading lathe made by the Automatic Machine Co., Bridgeport, Conn., a solid nut about 9 inches long is used in the carriage apron in place of the common opening nut found in engine lathes. This nut is bushed with babbitt and the thread is cut in the babbitt on one of their automatic lathes. To clear out the fins and size the nut it is, of course, necessary to run through a tap, but if a hardened tap was used for the purpose, the accuracy of the lead would very likely be destroyed, so a soft tap is used instead. The tap is made from unannealed steel and fluted in the ordinary manner, but is not hardened. The amount of metal that it has to remove is small, so the difficulty that some might anticipate from using an unhardened tap is not serious.

In this shop a form of lathe tool that is largely employed for thread-cutting, consists of a simple holder having a setscrew to hold the steel cutter, which is made of round stock. The cutter is milled to the required width with straddle mills and is relieved on the side by filing before hardening. The cutter, having a round body, may be twisted to any angle required by the pitch of the thread to be cut. This often saves considerable grinding and fussing to get the angle of the blade just right, so that it will clear on the sides.

Roller bearings have received a somewhat severe test in connection with the perfecting printing presses of *The Providence Journal*, Providence, R. I. Roller bearings have been used in Providence so successfully for jewelers' rolling mills and other heavy work that when a Hoe perfecting press was ordered for the *Journal* office, roller bearings were specified, much against the advice of the printing press factory. In printing, as in perhaps no other class of work, the cylinders which give the impression of the type upon the paper must stand up rigidly to their work without deflection or uneven motion tending to produce slurring. In fine "cut" work especially is this necessary, otherwise the beautiful results obtained in our best illustrated magazines would be impossible. It is generally assumed that the journals of the impression cylinders must be closely fitted in their bearings, and it would naturally be supposed that a solid metal-to-metal contact would be better than where rollers are placed between the two surfaces. *The Providence Journal* has recently stated, however, that the roller bearings have given perfect satisfaction. The bearings have worn smoothly and evenly and have required no attention. After operating five years, inspection showed that neither the rolls nor the surfaces of the bearings or journals had worn perceptibly. The press can be turned easily by hand, and it is estimated that there is a saving of about 4 horse power in operating it, through the reduction in friction at the bearings. The Hoe company now use roller bearings regularly on many of their machines.

NOTES OF TRAVEL.

GAS AND OIL ENGINES IN GERMANY.

Editor MACHINERY:

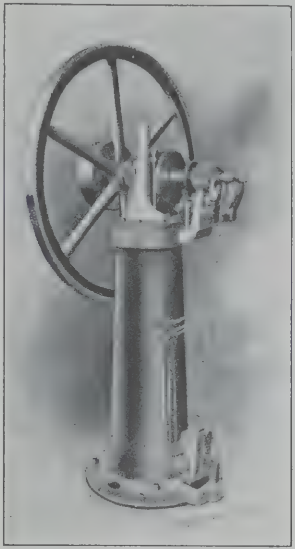


Fig. 1. The First Gas Engine. Exhibited at Paris in 1867. The Piston drives the Shaft through a Rack, Pinion and Ratchet Mechanism.

A very complete and most excellent display of internal combustion engines was made by the Gasmotoren-Fabrik-Deutz at the Dusseldorf Exhibition in the summer of 1902. The display was so representative of internal combustion motor practice in Germany, and so valuable, that it led to a visit to the works of the company at Deutz near Cologne. A cordial reception and free access to the entire establishment were granted. While passing through the various departments information was freely given and questions fully answered.

In the two places, the exhibition and the works, gas, oil and spirit engines for practically all such purposes as steam, electric and water motors are commonly applied to, were seen in operation and under construction in sizes ranging from one-half horse power to 1,200 horse power. Several types of gas generators for supplying fuel to the gas motors were also shown in operation. The generators are made in different types to meet the conditions of gas making from soft and hard coal, and from coke.

The first of all gas motors was in operation at the exhibition. It is the same that was exhibited at the Paris Exhibition in 1867, where it received the gold medal. Its capacity is one-half horse power. Although it is so well known, a brief explanation and an illustration may, nevertheless, be acceptable. The walls of the vertical cylinder form the lower part of the pedestal and frame which support the horizontal main shaft above and slightly to one side of the center line of the cylinder. There is neither crank nor connecting-rod for transmitting the motion of the piston to the main shaft. Instead of this now universally-adopted device the piston drives the main shaft through a gear rack attached to the center of the piston, after the manner of a piston rod, and engaging with a spur gear on the shaft. The gear is free to rotate in one direction on the main shaft, but drags the shaft with it in the opposite direction by means of a pawl and ratchet connection. When the piston is projected upward by the explosion of a charge of air and gas mixture the gear is rotated in its free direction on the main shaft by the piston rack. As the piston descends by its own weight and atmospheric pressure, it drives the main shaft. By this device no heavy shock is brought upon the power transmitting parts of the machine. The design is not suitable to large powers, however, and even for small capacities a large machine is required.

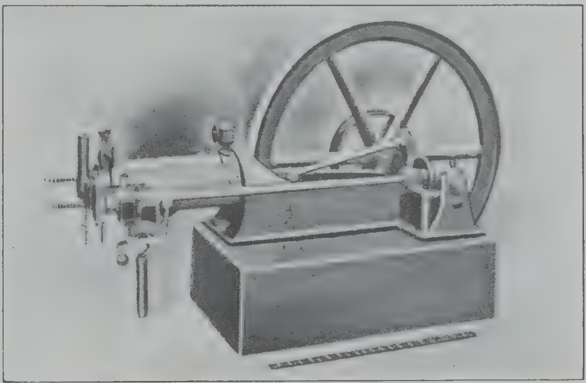


Fig. 2. The First Four-stroke Gas Engine. Otto Cycle, Connecting-rod and Crank.

The first gas engine with crank and connecting rod was also exhibited. It is spoken of by the manufacturers as the "four-stroke" engine. An explosion can occur not oftener than every fourth single stroke of the piston in accordance with the now well-known Otto cycle. The type of this engine, with modifications and improvements, is still used in the Otto gas engine.

The works of the Gasmotoren-Fabrik-Deutz have a floor space of ninety thousand square meters (about 963,000 square feet). There are about two thousand employes. Power for the machinery is furnished by gas motors suitably located about the buildings. The entire works are lighted by electric light, arc and incandescent. All the electric generators are driven by gas motors. Storage batteries are used in connection with the incandescent lamps to secure a steady illumination. All the lights were burning satisfactorily late in the evening of a winter day. There was no indication of flickering. There are two electric plants, one in the old, and the other in the new section of the buildings.

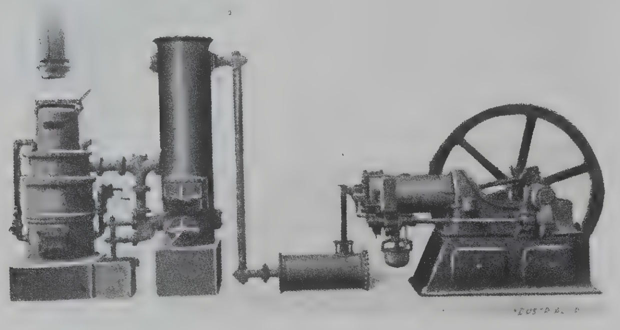


Fig. 3. Power Unit, consisting of a Suction or Inhalation Gas Generator, Washer and Engine. For Hard Coal and Coke.

One pair of electric generators was belt-driven by a two-hundred horse power engine receiving gas from a gas generating plant of the type known as the Saug-Generatorgas-Anlage (suction or inhalation gas generating plant). The necessary draft for keeping up combustion in the gas generator is caused by the suction of the engine as it takes its charge of explosive mixture. Air and steam are drawn into the hot coals at the bottom. The gas plant, together with the motor, are shown in the illustration. The fuel used when the plant was seen in operation was anthracite pea coal. The generator is adapted to both this and coke. No gas storage tank of variable capacity is used in connection with this power generating unit. The gas passes from the generator on the left in the illustration to the washer immediately adjoining it, and thence direct to the engine. The small tank between the engine and washer has enough capacity to allow, by the expansion of the gas in it, for the sudden demands of the engine for fuel. The engine, by its suction or inhalation action, draws just sufficient air and steam into the bed of hot coals in the generator to produce the amount of gas needed to meet the demands for power. Moisture from the washer may collect in the drum between the washer and engine. For the sake of cleanliness and absence of gas in the engine room, the producer and washer are placed in a room separated from the engine by a partition wall. A one-thousand horse power gas producing plant of the above type was in operation at the Dusseldorf Exhibition.

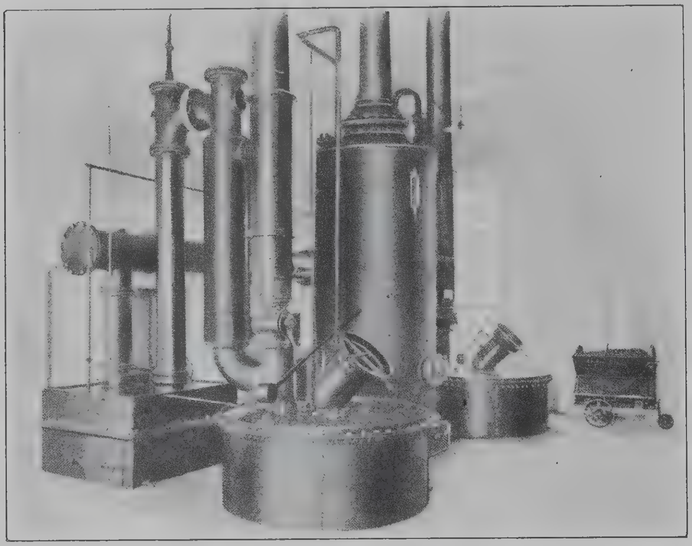


Fig. 4. Illuminating Gas Plant.

For the utilization of the soft coals of Germany another type of gas generator is built. Unlike the old retort method of gas production with a residue of coke, this generator consumes the coal completely, except such ash as remains from an ordinary fire. The arrangement of this Braunkohlen-Generatorgas-Anlage (brown or soft coal gas generator plant) is shown in the cut, Fig. 5. The generator *A* is closed during the production of gas. Steam and air are blown into it through the pipe connected to the bottom of the shell; or air alone may be forced in. The gas passes from the generator through the condenser *B*, washer *C*, condenser *D* and on into the tank *E*. The latter has a floating upper half with edges submerged in water. The coal is charged on through the hopper at the top of the generator *A*, and the ash removed from the bottom. The reservoir supplies gas to the engines when the generator is opened for charging and removing the ash, and also stores the gas during short stoppages of the engine. Although especially designed for soft coal, this generator can be used for coke and hard coal. It is said that it will operate successfully with any coal on the continent. A sixty horse power gas plant of this type was in operation at the exhibition and another at the works of the company. One of these generators will retain fire for fourteen days when out of service, and can be brought up to its working capacity in a fraction of an hour. The makers state that, with this generator, power can be delivered by a gas engine at a cost from two-thirds to one and a quarter pfennigs (one-sixth to five-sixteenths of a cent) per horse power per hour. They also point out that the cost of a horse power is much less for the gas motor than the steam engine. This producer is made in capacities ranging from fifty to one thousand horse power.

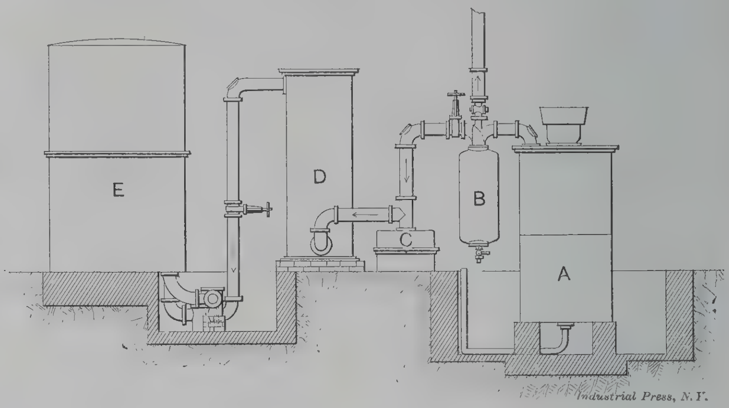


Fig. 5. Soft Coal Gas Generator, Condensers, Washer and Tank. May also be used for Hard Coal and Coke.

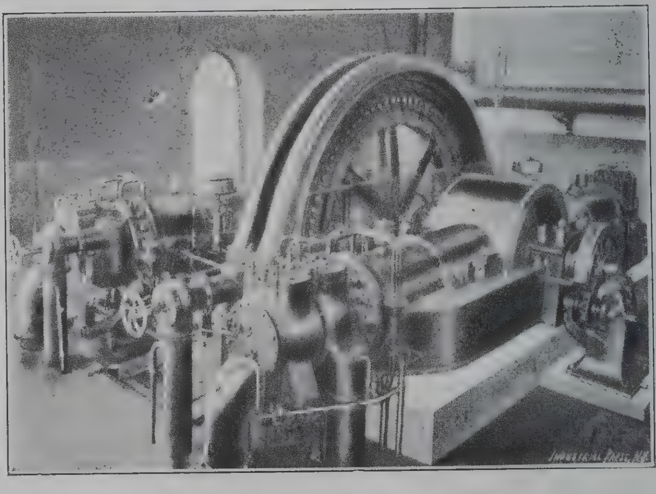


Fig. 6. Four-cylinder Blast Furnace Gas Motor of 1000 H. P.

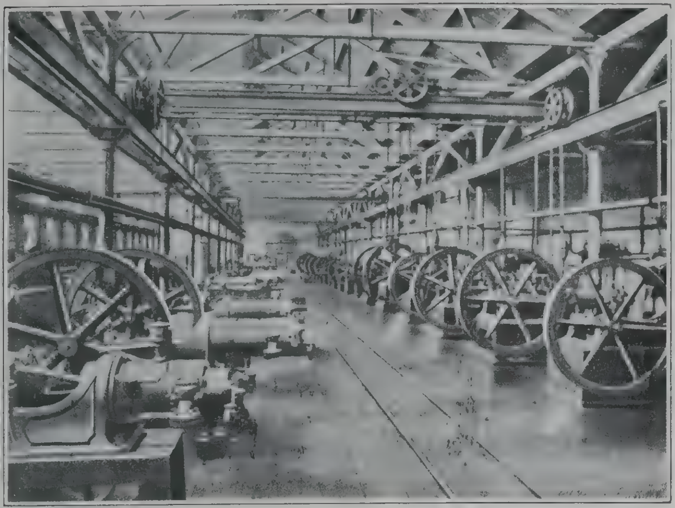
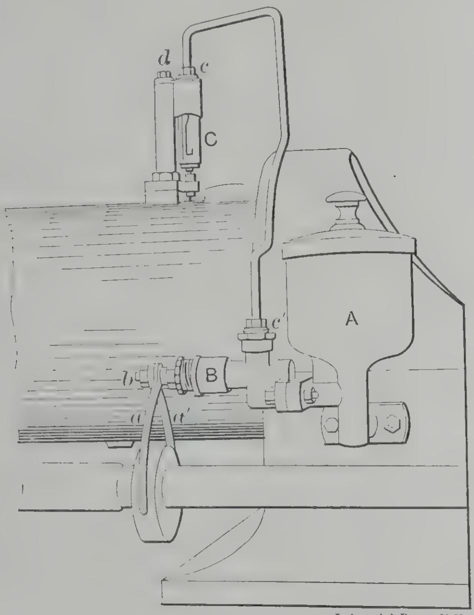


Fig. 7. Testing Room for Small Motors, Gasmotoren-Fabrik, Deutz.

Many of the engines built by the firm are suitable for blast furnace gas. Such a one of twelve hundred horse power capacity with four cylinders was exhibited. Others of one thousand horse power each were well toward completion in the works.

Gas motors forming part of direct-connected units of large capacity are in operation in several cities in Germany and other continental countries for electric lighting and electric power purposes. Stationary electric motors and electric tram cars are among the types of machinery supplied with current. The engines are also used extensively to pump water for city supply.



Industrial Press, N. Y.

Fig. 8. Simple Lubricator, Positively Driven.

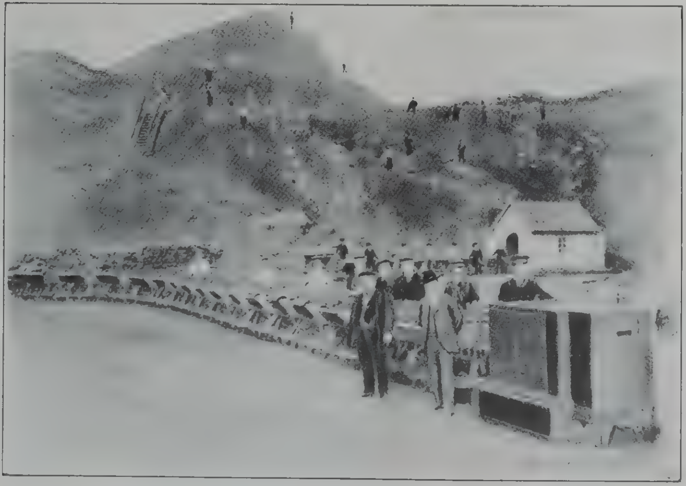


Fig. 9. Gasoline Locomotive operating Slag Cars.

Liquid burning internal engines are made in forms adapted to the propulsion of boats, winches, fire engines both automobile and horse drawn, traction engines for threshing machines and portable sawmills, traction engines for haulage purposes chiefly, and numerous other purposes. Internal combustion engines for crude petroleum are included in the output. This type has not yet been adapted to very small powers, however, on account of clogging in the very small tube used for conveying the petroleum from the pump to the engine cylinder. An industrial railway with motive power supplied by an oil-burning internal combustion engine was in operation alongside another of the same size but having a storage-cell electric locomotive. The showing of the oil locomotive was very good indeed.

All motors are tested before leaving the works. The testing rooms occupy a considerable portion of the plant. That for small motors is very completely fitted with all appliances necessary for convenience in making trials.

The cylinder lubricator, an important adjunct to the internal combustion engine, is driven by a cam on the valve-operating shaft which runs parallel to the length of the engine. There is a double-contact cam follower, resembling very closely a pair of jointed outside calipers, which straddles the cam. The quantity of oil supplied to the cylinder depends upon the amount of motion of the follower. This is regulated by a screw which adjusts the distance between the legs of the follower, just as in a pair of screw-adjusted calipers. This appliance is mentioned in detail for the reason that it has an important feature that is lacking in the very common form of belt-driven lubricator, namely, positiveness of action. It is not uncommon to see a belt-driven lubricator stop while the engine is running. Any one familiar with the gas and oil engine knows how serious may be the result of the consequent failure of cylinder lubrication.

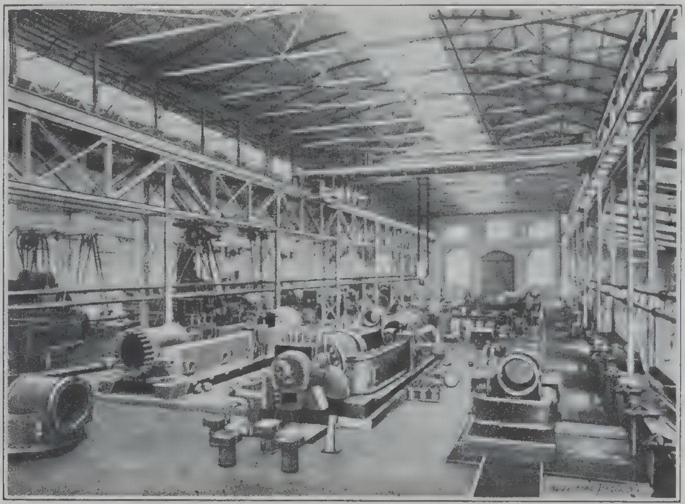


Fig. 10. Erecting Room for Large Motors, Gasmotoren-Fabrik, Deutz.

The company states that there are in operation more than sixty-one thousand of its motors, aggregating in round numbers, three hundred and twenty-five thousand horse power.

Forrest R. Jones.

London, England.

* * *

A writer in the *Foundry* who has had considerable experience in such matters, says that defective iron castings can be more easily repaired by "burning" with brass than with iron. Less metal is required and the results average better. As an illustration, he quotes a cylinder that was nearly machined when a hole was discovered in the barrel near one of the ports. It was located so that it could not be plugged and to burn it was considered a big risk, besides there was not room enough inside the casting to hold sufficient iron to burn it. The cylinder was repaired quite successfully by burning the hole with brass. The metal used was composed of copper 16 parts, yellow metal 6 parts, lead 3 parts, and tin 1 part. For burning iron it should be "jumping" hot. The metal is very fluid, searching, soft and easily machined, and is malleable when cold, so that it may be calked.

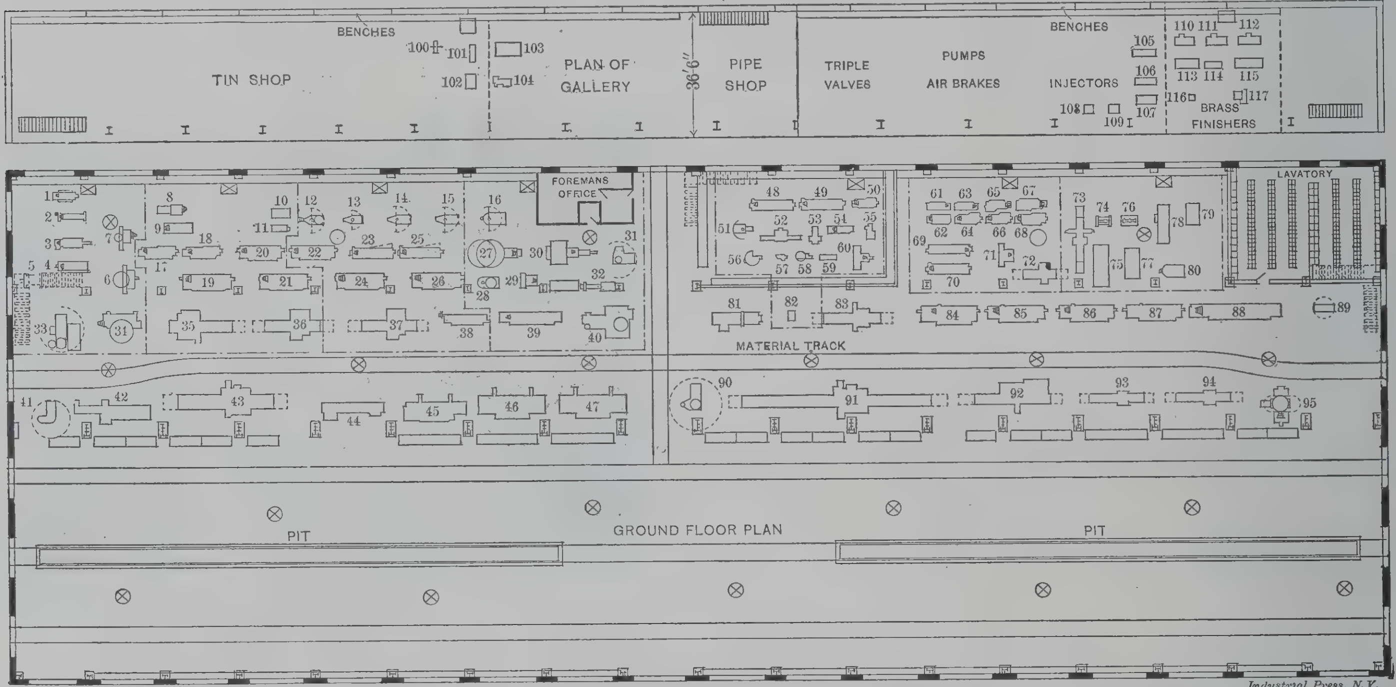
MOTOR POWER FOR MACHINE TOOLS.

DATA UPON MOTOR EQUIPMENT AND TESTS OF POWER FROM TWO RAILROAD SHOPS.

The Union Pacific Railroad is building extensive repair shops at Omaha, Nebraska, which will be equipped with modern tools and appliances throughout. The accompanying list of motors and tools, and the diagram showing the arrangement of the tools in the shop were first published in the *Railway Age*, from which the first part of the article is taken. The results of the tests at the locomotive shops of the Buffalo, Rochester and Pittsburg Railway, which follow the list of tools, were furnished by the Westinghouse companies, Pittsburg.

Tools in Machine Shop.

	Motor H.P.
1. Turret lathe, 1¾ inches by 18 inches	2
2. Screw machine, No. 3	5
3. Turret lathe, 2 inches by 24 inches	2
4. Twenty-two-inch turret lathe, Bullard H	3½
5. Nut tapper, 5 spindles, Union Pacific	
6. Boring and turning mill, 37-inch	4
7. Boring and turning mill, 51-inch	5
8. Bolt cutter, 2½-inch, single	1
9. Bolt cutter, 3½-inch, single	2
10. Bolt cutter, 1½-inch, double Acme	2
11. Bolt cutter	1
12. Drill, radial, 8 feet	2
13. Drill press, 30-inch, upright	2
14. Drill, 44-inch, upright, Hamilton	5
15. Drill, 44-inch, upright, Hamilton	5
16. Drill, 50-inch, upright, automatic tapping attachment	5
17. Lathe, 20 inches by 10 feet, taper attachment	2½
18. Lathe, 20 inches by 10 feet, taper attachment	2½
19. Engine lathe, 30 inches by 14 feet	2½
20. Engine lathe, 26 inches by 12 feet	2½
21. Engine lathe, 30 inches by 14 feet	2½
22. Engine lathe, 26 inches by 12 feet	2½
23. Lathe, 24 inches by 12 feet	2½
24. Lathe, 30 inches by 14 feet	2½
25. Lathe, 22 inches by 12 feet	2½
26. Lathe, 30 inches by 14 feet	2½
27. Gisholt turret lathe, 28 inches, automatic	5
28. Drill, 50 by 42 inches	2½
29. Milling machine, Universal	3
30. Horizontal boring machine	5
31. Drill press, No. 0, Bickford	3
32. Air press, Union Pacific	
33. Drill, radial, 8 feet	4
34. Boring and turning mill, 8 feet 2 inches by 7 feet	6
35. Planer, 60 by 60 inches by 12 feet	8
36. Planer, 36 by 36 inches by 12 feet	6
37. Planer, 36 by 36 inches by 12 feet	6
38. Locomotive axle lathe, No. 6	5
39. Engine lathe, 26 inches by 16 feet	3
40. Slotter, 24 inches	8
41. Drill, radial, 5 feet, Universal	3
42. Three-spindle cylinder borer	10
43. Planer, 72 by 84 inches by 16 feet	10-25
44. Hydraulic driving wheel press, 90 inches, 300 tons	10
45. Driving wheel lathe, 80 inches	7½
46. Driving-wheel lathe, 90 inches	15
47. Driving-wheel lathe, 90 inches	15
48. Lathe, 24 inches by 12 feet, taper attachment	2½
49. Lathe, 22 inches by 12 feet	2
50. Lathe, 16 inches by 6 feet	1-2
51. Drill press 30 inches upright	2
52. Universal grinder, No. 2, imp	2
53. Shaper, 16 inches, back geared	1
54. Brass lathe, Monitor, 15 inches by 5 feet	1½
55. Gear cutter	4
56. Tool grinder, No 90	½
57. Twist drill grinder, Yankee	½
58. Universal grinder, No. 3	2½
59. Emery wheels	½
60. Milling machine, No. 13, Universal	2
61. Lathe, 16 inches by 6 feet	1
62. Lathe, 16 inches by 6 feet	1-2
63. Lathe, 16 inches by 6 feet	1-2
64. Lathe, 16 inches by 6 feet	1-2
65. Lathe, 16 inches by 6 feet	1-2
66. Lathe, 16 inches by 6 feet	1-2
67. Lathe, 18 inches by 8 feet	1-2
68. Lathe, 18 inches by 8 feet	1-2
69. Lathe, 22 inches by 12 feet	2
70. Lathe, 22 inches by 12 feet	2
71. Milling machine, Universal, No. 1	3
72. Planer, 26 by 26 inches by 6 feet	3½
73. Automatic surfacer	2
74. Emery wheels, double	2
75. Shaper, 42-inch, Morton draw stroke	6
76. Emery wheels, double	2
77. Shaper, 30-inch, Morton draw stroke	3½
78. Grindstone, 60-inch	3
79. Face plate	
80. Drill, 50 by 42 inches	3
81. Slotter, 18 inches	7½
82. Seventy-five pound power hammer	2
83. Planer, 36 by 36 inches by 14 feet	10
84. Lathe, 42 inches by 16 feet, triple-geared	3
85. Lathe, 38 inches by 16 feet, triple geared	3
86. Lathe, 36 inches by 16 feet	3
87. Lathe, 36 inches by 16 feet	3
88. Lathe, 37 inches by 22 feet	3
89. Handpress	
90. Drill, radial, No. 1	3
91. Planer, 60 by 60 inches by 20 feet	20
92. Planer, 38 by 38 inches by 14 feet	10
93. Planer, 32 by 32 inches by 10 feet	5
94. Planer, 32 by 32 inches by 10 feet	5
95. Vertical milling machine, 32 inches	10



Industrial Press, N.Y.

Arrangement of Tools, Union Pacific Shops at Omaha.

Machine Shop Gallery.

	Motor H.P.
100. Sturtevant Fan	10
101. Drill press, friction, No. 2	1
102. Cutting blanking press	3
103. Pipe cutter, 6-inch	3
104. Pipe cutter, 3-inch	3
105. Lathe, 16 inches by 6 feet, for triple valves	1½
106. Lathe, 16 inches by 6 feet, for triple valves	1½
107. Drill press, 22 inches by 18 inches, Prentiss	1
108. Buffing wheel, for brass	½
109. Emery grinder	½
110. Lathe, Fox turret, 16 inches by 6 feet	2
111. Lathe, Fox turret, 16 inches by 6 feet	2
112. Lathe, Fox turret, 18 inches by 6 feet	2
113. Lathe, Fox turret, 18 inches by 6 feet	2-3
114. Lathe, Monitor, brass, 15 inches by 5 feet	1½
115. Lathe, Fox turret, 18 inches by 6 feet	2-3
116. Drill, 24 inches, upright	1
117. Milling machine, No. 1	3

The machine and erecting shop is 150 x 400 feet. It is arranged on the longitudinal plan with three tracks on the erecting side, spaced 23 feet center to center, and the middle track has two pits 150 feet long. A fourth track is located 32 feet from the inner track, for conveying material to the heavy lathes, planers, etc. The west side of the shop is provided with a gallery running the full length and is located at a height that gives 19 feet head room beneath the floor girders and the ground floor. In the grouping of the machines the object has been to so locate them as to facilitate the passage of work through the shop and to avoid, so far as possible, the work traveling twice over the same route.

TESTS AT THE LOCOMOTIVE SHOPS OF THE BUFFALO, ROCHESTER & PITTSBURG RAILWAY.

Tests have recently been made at the locomotive shops of the Buffalo, Rochester & Pittsburg Railway for the purpose of ascertaining the amount of power used by the different machine tools when operating on regular routine work. As the tools are driven by the group system it was also possible to determine the percentage of power absorbed by the shafting and belting used in the various groups. The net power consumed by the various tools was not obtained directly, but by subtraction. All measurements were made by voltmeter and an ammeter in the motor circuit. These indicated the electrical horse power delivered to the motor, and the brake horse power delivered by the motor at any given load was then determined approximately by means of the motor efficiency curve. The amount of power consumed by the shafting and belting being known, and then the amount consumed with the tool running being taken, the first quantity was subtracted from the latter to give the amount actually consumed by the tool. This probably gave very nearly the correct results, since the energy lost in shafting and belting is very nearly constant at various loads. The tests were made while the shops were in full daily operation and it was for that reason impossible in many cases to make as direct measurements as might seem desirable.

The steam engines in the power house, and the generators and motors were installed by the Westinghouse companies. There are three separate units in the power house, one D. C. for power and lighting for the day load; one D. C. for power and lighting for the night load; and one A. C. unit for lighting the grounds and transmitting current for lighting car shops and several railway stations at a distance. The different groups of tools were driven by shunt motors which at present have rather small loads allotted to them in view of possible increases in the capacity of the shops at some future time and from the fact that experiments are now being conducted with high-cutting steels, which, if adopted, will considerably increase the demands for power.

The tests, in addition to furnishing data relating to the power required for various tools, when starting, running light, and cutting, also make possible some estimation of the merits of roller bearings for shaft hangers. The line shafts are of cold-rolled steel and are carried on Hyatt roller bearings, and a shaft 200 feet long, without belts, can be turned by hand. But in spite of the unusual efficiency of the bearings it will be noted that the power consumed by the tool is often less than that lost in transmission. Nevertheless the capacity in motors required for the group drive is two and a half times smaller than it would have been had each tool been provided with an individual motor. It is a question as to how far the low average power taken by large groups of tools in operation may be due to the flywheel effect of the shafts and pulleys.

The locomotive-erecting, boiler and machine shop consists of a middle aisle for erecting, and of two shed bays equipped with shafting for driving the machine tools. Two 50-ton, electric traveling cranes have a runway in the middle aisle. There are five lines of shafting driven by five shunt motors in the shed bays and the sections are designated as wheel section and boiler section in one bay, and lathe, tool, and flue sections in the opposite bays.

Tests were run in the different sections upon various groupings of the tools, and also upon single tools in each section, but space will be given here only to the results obtained with the single tools as it is not likely that the group tests would be of material value to any not interested in this particular plant. We include, however, the results of tests on the shafting and belting.

In the wheel section the line shaft is 200 feet long, 2½ inches in diameter, and has 26 hangers. It was inconvenient in this instance to obtain a test of the line shaft alone, but a test of the line shaft and counters indicated only 1.5 horse power.

A 42-inch wheel lathe with one tool cutting took, on starting up, 4.6 horse power, and on steady running .5 horse power.

An emery wheel took .7 horse power.

A 79-inch wheel lathe with two tools making roughing cuts on a pair of drivers took 4 horse power.

An 84-inch boring mill boring an 8-inch cylinder took 2 horse power.

A 60-inch planer cutting a cast-iron cylinder took 2 horse power, and a maximum at reversal of 8.5 horse power.

An 18-inch slotter with tools of ¾-inch face cutting steel took .3 horse power, and a maximum at reversal of 1.2 horse power.

A band saw starting up took 6.3 horse power and running light or cutting 4-inch oak 4 horse power; it seemed to make no difference whether the saw was cutting or not.

In the boiler section all the counter-belts were thrown off and the line shaft tested alone, with a result of .3 horse power. This line shaft is 170 feet long, 2½ inches in diameter and has 19 hangers. The speed of the line shaft was 158 revolutions per minute. A test of the line shaft and countershafts only, gave an average of 2 horse power.

First a group of several tools was tested; then a single tool, the No. 4 Hilles & Jones 48-inch punch and shear was thrown in, and starting up light took 6.9 horse power, settling down to .4 horse power. Shearing 5-16-inch steel plate, it required 3 horse power.

A 6-foot radial drill was then added, and at starting up light took 3.6 horse power, settling down to 1.1 horse power. A 1½-inch drill cutting in steel gave 1.5 horse power.

A set of 12-foot rolls was then added, and starting up light showed 7.3 horse power, settling down to 4.75 horse power. Rolling steel plates, ½-inch by 8-inch required 5.3 horse power.

A 1-inch stay-bolt cutter added to the above took on starting up 4.5 horse power, and cutting 12 threads per inch gave 2.1 horse power.

In the lathe section the line shaft and counters gave 4.1 horse power. A test of the line shaft with counter-belts off gave .7 horse power. The speed of the line shaft was 155 revolutions per minute. The line shaft is 180 feet long, 2½ inches in diameter, and has 22 hangers.

Besides the group tests it was found that a single 26-inch planer cutting cast-iron took 1 horse power, and at reversal 3.5 horse power.

A 16-inch shaper cutting 1-32-inch steel at 12-inch stroke took .9 horse power, with a minimum of .2 horse power and a maximum of 1.4 horse power.

A 24-inch turret lathe cutting required .3 horse power.

A 24-inch lathe boring brass took .03 horse power.

In the tool section the line shaft and counters required 2.8 horse power. The line shaft is 140 feet long, 2½ inches in diameter, and has 20 hangers. It was not convenient to obtain a test of the line shaft alone. The speed of the line shaft was 155 revolutions per minute.

A single grinder took in starting up 9.7 horse power, and grinding 1.95 horse power.

A 28-inch lathe took on starting 4.7 horse power, and cutting steel 2.5 horse power.

In the flue section a test of the line shaft with all counters gave .6 horse power. A test of the line shaft gave .035 horse power. The line shaft is 90 feet long, 2½ inches in diameter, and has 12 hangers.

A single flue welder with blowing fan attached required on starting up 7.1 horse power; running light it took 3.4 horse power.

The pipe cutter cutting 2½-inch pipe took .06 horse power.

The auto-flue cleaner, cleaning 2-inch flue, took .2 horse power.

* * *

The floating machine shop Vulcan, used by the navy department during the Spanish war, created much interest at the time of its inception. There is now a similar novelty on Lake Champlain, but in this instance in the wood-working line. A floating sawmill is in use there, which resembles its predecessor, the ark, but with modern improvements. It is a two story structure with boiler, engine and sawmill on the first floor, or lower deck, according to whether the sawmill or marine features are supposed to predominate, and the quarters for the crew on the upper deck. There was a time when a great deal of timber was cut on the shores of Lake Champlain, but now the shores are not so heavily wooded as formerly, there are many stray ends of timber, that can be profitably worked up into lumber by this floating mill.

STEAM ENGINE SPECIFICATIONS.

FORM FOR SPECIFICATIONS FOR MARINE ENGINES.

The following form for marine engine specifications was prepared by our correspondent, Mr. William Burlingham, and first appeared in "Steam Engineering" when that journal was published by The Industrial Press, the publishers of Machinery.. While these specifications apply specifically to a triple-expansion engine of the commercial marine class destined for a passenger boat of 16-knots speed, they are, in general, applicable to the type of engines that are in the majority in use on our coast. They will apply, however, equally well to land work with some judicious pruning of the features particularly applicable to marine conditions, such as thrust bearings, propeller wheels, etc. The materials specified are suitable for a first-class engine, but changes can, of course, be made to meet the conditions in that respect.

The usual method of supplying specifications is by blueprints, but during the past few years, the best firms have made a practice of having their specifications printed, and cheaply but serviceably bound. The latter is by far the better method. The general specifications at the end may be omitted if thought necessary and all the machine and foundry work allowed to go as the local inspector decides.

Machinery Specifications for Triple-expansion Marine Engines.

High Pressure Cylinder............diameter..........inches.
Intermediate Cylinder.............diameter..........inches.
Low Pressure Cylinder............diameter..........inches.
Stroke ....inches.
Revolutions ....per minute.
Steam Pressure ....pounds per square inch.
For a boat of following dimensions:
Length on L. W. L...........................
Length over all...............................
Beam, Moulded ....
Depth, Moulded ....
Draft, Mean ....
Displacement ....
Speed..........at............tons displacement.

General Description.

To be a vertical, inverted, direct-acting, surface condensing engine, of the triple-expansion type, having the high-pressure cylinder forward, the low-pressure cylinder aft and the mean-pressure between the two; to be built to withstand a working pressure of......pounds of steam per square inch, and cranks to be set at angles of 120 degrees apart.

Cylinders: The high, mean and low pressure cylinders to be respectively ...., ..., and .... inches in diameter and each to have a stroke of .... inches; to be of hard, close-grained cast iron .... inches thick, perfectly free from all defects and to be truly bored.

The high-pressure cylinder to be fitted with a separate liner barrel of cast iron as hard as can be properly worked, bolted to the cylinder, and to be fitted with a piston valve; the mean and low-pressure cylinders to be fitted with double-ported slide valves and separate valve faces bolted to the main casting by composition screws. Drain valves to be fitted to the bottoms of cylinders and valve chests and arranged so that they can be operated from the working floor; spring safety valves to be fitted to the receivers and set to .... pounds and .... pounds per square inch, for the low and intermediate, respectively. All stuffing boxes for piston rods and valve stems of main engines to be fitted with metallic packing; brasses to be provided for indicators, etc., and peep holes to be provided in chest for setting valves.

Lagging: Cylinders and valve chests to be covered with non-conducting material and cased or lagged with black walnut, neatly secured with brass button-head screws; or, if preferred, Russia iron may be used in place of walnut.

Cylinder Heads:. To be of cast iron of sufficient depth to give great strength; to be ribbed and covered with polished iron plates.

Pistons: To be of cast steel, of sufficient depth to give complete strength, to have cast iron packing rings and followers, and to be secured with steel bolts and brass nuts.

Piston Rods: To be of the best mild steel, well fitted to crossheads and pistons, and secured to each by a large nut.

Crossheads:.To be of wrought iron or steel with crosshead pins forged on; slide box to be of cast iron lined with anti-friction metal and securely bolted to crosshead.

Framing: Front column to be of polished forged steel, one to each cylinder, with large flanges forged on at each end, and to be firmly bolted to bed plate and to cylinders. The columns on the condenser side to be of cast iron, box shaped, one to each cylinder, and to be thoroughly bolted to condensers and cylinders; to these cast-iron columns the main guide plates are to be bolted.

Condenser:. To be a surface condenser of cast iron, securely bolted to bed plate; to have tubes and tube plates of brass; tubes to be of Muntz metal secured with brass screw glands and cotton cord, each tube to be .... inches outside diameter; a sufficient amount of cooling surface to be provided for condensing purposes, or .... square feet, and also a supplemental feed and cock for soda.

Bed Plate:. To be of cast iron girder or box shape; to be made in two pieces, firmly bolted together, and provided with all flanges, brackets, etc., necessary to bolt it securely to the condenser and foundation. All journals to be .... inches in diameter; boxes to be of brass, lined with the best anti-friction metal, and held in position by heavy steel bolts; caps to be fitted with keepers; each journal to be fitted with a large oil cup.

Main Guide Bars:. To be of cast iron, box section, securely bolted to the columns on the condenser side and arranged to pass water through them. The outside dimensions of cross-section of these bars to be .... inches by .... inches.

Connecting Rods: To be forged of the best mild steel, and to be forked and fitted with two bearings at the crosshead end, each .... inches long; crank pin bearing to be .... inches in diameter; all to be fitted with brass boxes lined with white metal. Bolts, keepers and caps to be of steel or wrought iron, finished bright.

Crank Shaft:. To be of the built-up type of the best mild steel; webs of the best hammered iron; shafts .... inches in diameter, provided with the proper couplings and bolts; pins to be .... inches in diameter, all forged in and well keyed together.

Slide Valves: To be of hard close-grained cast iron, accurately surfaced on the slide faces and secured to stem by large nuts and washers; nuts to be of brass and washers of wrought iron.

Stop Valve: To be a balanced valve not less than .... inches in diameter net; of cast iron body, with valves, seat and stem of brass.

Valve and Reversing Gear: To be of Stephenson link reversing type, operated by steam; valve stems to be of mild steel, and fitted with brass sliding blocks, with large bearing surfaces; eccentric rods to be forged of the best mild steel or scrap iron with adjustable brass bearings; eccentrics to be of cast iron, in halves, with large bearing surfaces.

Starting Gear: Handles for operating throttle valve, valves for admitting steam to each receiver, drain valves and reversing engine, all to be arranged so as to be conveniently operated from the working floor in the engine room.

Air Pump:. To be single acting, ... inches in diameter and .... inches stroke; working barrel to be of brass; foot valve, bucket and discharge valves, and guards also to be of brass; to be fitted with hard rubber valves well tested; bucket rod of steel covered with brass sleeve.

Circulating Pump: To be a centrifugal pump, driven by an independent engine; pump wheel to be of brass .... inches in diameter; shaft in water space to be covered with brass, running in lignum vitae brassings; engine cylinder to be .... inches in diameter and .... inches stroke, and pump to have ample capacity for condensing all steam that boilers will make, after being used by the engine.

Main Feed Pump: To be an independent feed pump driven by an independent engine; to be of the duplex type and sufficiently large to supply all the boilers with water without overworking; to be fitted with composition pistons or plungers, piston rods, valve seats, etc.

Bilge Pumps: To have two bilge pumps to work from the air pump crosshead; pump chambers to be of cast iron, plungers of brass, valve seat chest of cast iron fitted with brass valves and seats and air chambers of cast iron.

Pump Gear:. Air and bilge pumps to be connected with one wrought iron or mild steel crosshead, operated by links and beams from the main crosshead of the engine; beams to be formed of double plates of wrought iron or steel; both front and back links to be fitted with brass boxes adjusted by gibs and keys.

Power Turning Gear: To consist of a large cast iron worm wheel, driven by an independent engine; the worm engine to be fitted with reversing gear.

OR,

Hand Turning Gear: To consist of a large cast-iron wheel fitted on after coupling; rim of wheel to be fitted for pinch bar.

Shafting: Crank and outboard or propeller shaft to be .... inches in diameter, of steel, and intermediate or line shafts, ... inches in diameter; couplings for all shafts to be forged on; propeller or outboard shaft to have brass sleeve at stuffing box and at the stern bearing and between these sleeves to be covered with a copper pipe made water-tight at its junction with each sleeve.

Thrust Bearing: To be of the horseshoe pattern; pedestals to be of cast iron, the ends and side walls of each of which will form a trough; the horseshoes, ..., in number, to be made of cast steel, lined with white metal and properly channeled for oil; brass adjusting nuts to be provided on the steel side rods, and attention to be paid to securing an efficient distribution of oil on the thrust surfaces.

Steady Bearings: One steady bearing to be provided for each section of shaft, to be of cast iron lined with best lining metal and to be fitted with caps and bolts.

Stern Tube Bearing: Stern pipe to be of cast iron, secured to the stern post by a large wrought-iron nut and to the stuffing-box bulkhead by a large flange, securely bolted to same; pipe to be supported in two places between the stern port and stuffing-box bulkhead; stern bearing to consist of a brass bushing filled with lignum vitae, the bearing to be .... feet long; forward end of stern pipe to be a long bearing with stuffing box at the end.

Propeller Wheel: To be of cast steel or other approved material and secured to the shaft by feather and nut, which is to be covered by a fair water cap properly bolted to hub of wheel.

Steam Pumps: To be of the best commercial pattern; one pump to be provided for the donkey boiler, of a capacity of .... gallons per minute and .... fire pumps and .... independent feed pumps, each to have steam cylinders .... inches in diameter and .... inches stroke, and water cylinders .... inches diameter and .... inches stroke; a water service pump to be provided for salt and fresh water tanks in the upper engine room for water closet and drinking purposes, the steam and water cylinders to be respectively .... inches and .... inches diameter and .... inches stroke; all of the above pumps to be of the duplex type; the fire pumps to be arranged to pump from bilge, boilers and tanks, and also fitted complete for fire purposes; feed pumps to be arranged to pump from hot well and fresh water tank; all pumps to have brass lined barrels, plungers of composition and valve seats of brass, arranged for pumping both salt and hot water.

Sea Connections: A sea valve to be provided for the circulating pump, the fire pump and the jet injection and water service pump; an outboard delivering valve for the air pump, the circulating pump and the bilge pump; all valves to have cast iron bodies with brass valve seats and stems; all sea valves to be provided with the proper gratings.

Pipe and Valves: All steam and water pipes of 2 inches diameter and above to be of copper; those below 2 inches in diameter to be of brass; bilge suction pipes to be of lead; all necessary strainers, etc., to be provided and fitted in place; all valves above 2½ inches in diameter to have cast iron bodies, brass valve seats and stems; all valves below 2½ inches in diameter to be entirely of brass.

Oil and Water Service: A complete lubricating arrangement to be fitted to all the bearings of the engine, and efficient lubricating devices to the minor moving parts, fed from tanks near the top of the engine; also a complete water service to all the main bearings, guides, thrust bearings and steady bearings.

Injectors: To be of ample size to furnish the boilers with water.

Packing: The piston rods of the high-, intermediate-, and low-pressure cylinders and all valve stems to be packed with approved metallic packing; all packing to be approved before installation.

Platforms, Ladders and Gratings: All working and other platforms, stairways and railings to be fitted as directed by the inspector; the lower floors of the engine and fire rooms to consist of ribbed steel plates and all gratings to be of steel; the ladders in the fire room to be of steel with figured cast iron treads; the railings in fire rooms to be of wrought iron pipe and those in engine room of brass polished, with brass knobs.

Indicator Gear: A complete indicator gear to be furnished and fitted in place on each cylinder, ready to attach indicators; indicators not to be furnished.

Gages and Clocks: In each engine room there is to be furnished and neatly fitted in place one main steam gage, one gage for each receiver, one counter, one vacuum gage and one clock—all to be of brass, nickel plated, and to have 8½-inch faces; in the fire room each boiler is to be provided with a gage of 5¾-inch face with japanned iron case, and also a steam gage for the donkey boiler.

Bells: One gong of satisfactory size to be provided in each engine room, and jingle bells, bell pulls, etc., and speaking tubes, all to be provided and fitted in place ready for work.

Traveler Bar: A traveler bar to be furnished and fitted to place for lifting cylinder heads; also eyebolts and carriers for disconnecting the different parts of the machinery.

Painting: The machinery is to be well painted with such colors as may be desired.

General Clause: The machinery is to be set up in the vessel and well fastened, and everything furnished to complete the same, together with all necessary tools, wrenches, etc., ready for service and to pass U. S. inspection laws; all to be of the best material and the work to be done in a first-class workmanlike manner the general arrangement of pipes and machinery to be similar to that of the steamer ....

General Specifications.

1. All castings must be sound and true to form, and before being painted must be well cleaned of sand and scale, and all fins and roughness removed.

2. No imperfect casting or unsound forging shall be used if the defects affect the strength or to a marked degree its slightness.

3. All flanges of castings must be faced and those coupled together will have their edges made fair with each other; the faces of all circular flanges to be grooved.

4. All bolt holes in permanently fixed parts must be reamed or drilled fair and true in place, and bolts furnished of bodies to fit them snugly.

5. All material used in the construction of the machinery must be of the best quality, the iron castings to be made of the best pig iron and not scrap, except where otherwise directed.

6. The Muntz metal must be of the best commercial quality.

7. The anti-friction metal must be of an approved kind.

8. All castings must be increased in thickness around core holes; core holes must be tapped and core plugs screwed in and locked, except where bolted covers are used, or where it may be directed that the holes be left open.

9. All steel forgings must be without welds and free from laminations.

10. All flanges, collars and offsets must have well rounded fillets.

11. All steel used in the construction must be tested in accordance with rules prescribed by the inspector.

12. One set of wrenches must be furnished complete; the wrenches for all nuts of bolts less than one inch in diameter

to be finished, and for all bolts over two inches in diameter to be box wrenches, where such can be used; socket wrenches to be furnished where required; open-end wrenches to be of steel or wrought iron with case-hardened jaws; all others of wrought iron or cast steel.

13. All brasses or bearings must be properly channeled for the distribution of oil.

14. Packing for stuffing boxes must be such as may be approved.

15. All small pins of working parts must be well case-hardened.

16. The auxiliary engines and all fittings and connections subjected to boiler pressure must be tested by water pressure to .... pounds to the square inch; after boilers are placed in the vessel and connections made, the boilers and pipe connections must be tested by steam to .... pounds per square inch.

17. All pressures to be above atmospheric pressure, and *not* absolute pressures.

18. All places where condensed steam can accumulate must be provided with drain pipes and cocks or valves of ample size, and with approved automatic traps; all traps to have by-pass pipes and valves for convenience in overhauling; the lowest parts of all water pipes and all pump cylinders and channel ways to have drain cocks with pipes, where required; the handles of all drain cocks to point downward when closed; all glass water gages under pressure to be fitted with valves of approved automatic closing patterns.

19. A copy of each working drawing must be furnished to the inspector before the work shown by that drawing is commenced.

20. All work must in every respect be of the first quality and executed in a workmanlike and substantial manner.

21. Any portion of the work found defective must, whether partially or entirely completed, be removed and satisfactorily replaced without extra charge.

22. Wherever duplicate pieces are furnished for one or two or more pieces of machinery of the same size, they must be made strictly interchangeable.

23. The steam cylinders of all auxiliary engines must be clotted with approved incombustible non-conducting material and lagged with Russia sheet iron; the non-conducting material to be the same as that used on the main engines.

24. Composition castings must be made of new materials, the various compositions to be by weight as follows: For all journal boxes and guide gibs, where not otherwise specified, Copper, 6-parts, Tin, 1-part and Zinc, ¼-part; for composition not otherwise specified, Copper, 88-per cent., Tin, 10-per cent. and Zinc, 2-per cent.; for Naval Brass, Copper, 62-per cent., Tin, 1-per cent. and Zinc, 37-per cent.

25. All working parts of machinery must be fitted with efficient lubricators, each with a sufficient oil capacity for four hours' running.

26. All iron boxes must be bushed with composition, and all glands must be of composition.

27. All bolt heads and nuts less than 3 inches must, except in special cases, conform to the United States Standard; screw threads on bolts and nuts must in all cases conform to the above standard; all finished bolts must, except as directed, be kept from turning by dowels or other suitable devices. The nuts of all bolts on moving parts, on pillow blocks, etc., as shown, must be locked, and the bolts must extend beyond the nuts, without threads, and be fitted with split pins. This specification is extended to apply to all pumps and auxiliary engines, as well as to parts of the main engines and boilers.

28. Each safety valve and each relief valve must have a spare spring; other spare parts for all special machinery must be supplied as directed by the inspector.

Tools.

The tools necessary for the engineer to be furnished as follows:

6 Spare glasses for water gages.
1 Set of fancy oilers and stand.
6 Squirt cans.
3 Quart feeders.
3 Funnels, assorted sizes.
1 Vise and bench.
Stocks, taps and dies, ¼ inch to 1 inch.
Ratchet and drills, assorted sizes.
12 Chisels, assorted.
2 Copper mauls, one for large and the other for small keys.
4 Hand hammers.
3 Monkey wrenches, 8, 12 and 18 inches.
1 Sledge.
1 Coal maul.
Necessary iron blocks and falls for hoisting machinery, and iron blocks and falls for cylinder heads.
Complete set of packing hooks and screws for all glands.
Necessary packing hooks for condenser.
Necessary wrenches for engineers' use.
Set of wrenches to be finished and set in walnut rack.
2 Pairs of pipe tongs, ⅝ inch to 2 inches.
3 Hose spanners for 2½-inch N. Y. Standard hose.
2 Scaling picks.
Set of scaling bars or chisels, assorted.
Two tube brushes and handles.
Hose for wetting ashes, 2 sections of 10 feet each.
One pair dividers, 6 inches.
1 Gallon measure.
1 Pair calipers.
1 Pair pliers, 6 inches.
1 Wire cutter, 6 inches.
1 Hand punch for iron.
6 Steel wedges.
1 Pair shears for sheet tin.
2 Pairs smiths' tongs.
1 Center punch.
1 Sight feed oil cup for the high-pressure cylinder.
1 Tallow cup for the intermediate and low-pressure cylinders.
1 Thermometer for feed water.
1 Salinometer.
1 Screw jack, 12 inches.
2 Oil tanks, 65 gallons each.
1 Waste can, 20 inches in diameter and 32 inches high.
1 Tallow can, 18 inches in diameter and 24 inches high, with ½-inch lid.
1 Set of caulking tools (boiler maker's).
2 Reamers (boiler maker's).
6 Files and handles, assorted.
1 Brace and bits, assorted.
1 Hand saw.
1 Lock saw.
1 Jack plane.
1 Hatchet.
2 Screw drivers, one large and one small.
6 Chisels and gouges.
1 Key wrench.
1 Grindstone.
1 Hand chisel (smith's).
2 Lockers for holding tools.
One full set of fire tools, viz:
4 Slice bars.
4 Hose.
2 Clinker hooks.
2 Pricks.
4 Shovels.
4 Lazy bars.
2 Ash buckets.

* * *

The practice of mounting blueprints on boards, sheet iron or pasteboard and shellacking them so as to better withstand grease, water and the other exigencies to which they will likely be subjected in the average shop, is well-known—better probably than the method of waterproofing unmounted blueprints that has been recently described in some of our exchanges. A number of sheets of absorbent cotton, about a foot square, are dipped in melted paraffin until thoroughly saturated; when withdrawn and cooled, they are ready for use. One of the saturated cloths is spread on a smooth surface, the dry print is placed on it, and a second waxed cloth on top. The whole is then ironed with a moderately hot flat-iron. The paper immediately absorbs the paraffin, and becomes translucent and waterproof. The lines of the print are intensified by the process, and there is no shrinking or distortion. As the wax is withdrawn from the cloths, more can be added by melting small pieces directly under the hot iron. By immersing the print in a bath of melted paraffin, the process is hastened, but the ironing is necessary to remove the surplus wax from the surface, unless the paper is to be directly exposed to the weather and not to be handled.

Blueprints treated in this way are said to be so impervious to moisture that they may be safely used out doors in damp weather, in mines and in other places where ordinary untreated blueprints would soon be ruined.

MOTOR DRIVEN TRUCK HAVING NOVEL VARIABLE SPEED MECHANISM.

At the late automobile show, held in Madison Square Garden, there was a sad lack of motor-driven vehicles for industrial purposes, that is, trucks. With a very few exceptions, all the machines exhibited were for pleasure, and most of them for pleasure of a very expensive kind, at least in the matter of first investment. One of the exceptions was a truck built by the Union Motor Truck Co., of Philadelphia, and so far as we are aware, it was one of the most interesting machines, mechanically, in the whole show. It has what no other one possessed, a variable-speed mechanism by which the speed can be varied at will of the driver from zero to the maximum, by minute increments, making it possible to vary the motion to any imaginable degree from nothing to full speed. The same holds for going backward. The leverage or "power" with which the truck is propelled varies in inverse ratio, being theoretically infinite at the slowest speed, which practically means, of course, that the truck is not propelled at all.

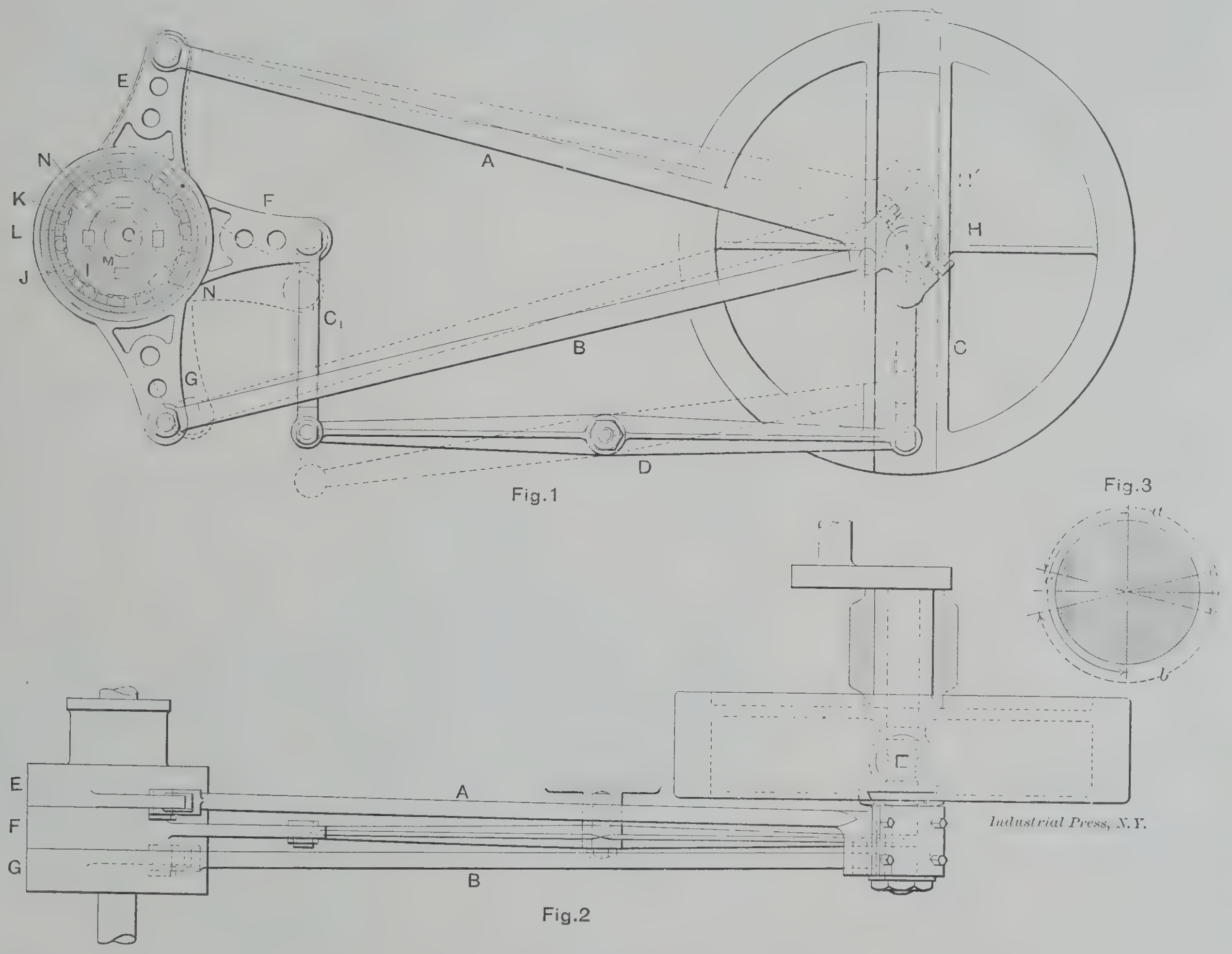


Fig.1

Fig.2

Fig.3

Industrial Press, N.Y.

Elevation and Plan of Truck Variable Speed Mechanism.

The truck has an internal combustion type motor with 4 cylinders 5 x 6½ inches stroke, connected to one crankshaft and developing 20 horse power at 400 revolutions per minute. The engine is located directly beneath the center of the truck platform and is connected to the rear axle by means of three rods, which take hold of three reversible roller ratchets. All three connecting-rods are connected to one crank-pin, which is located in the face of the flywheel. Means are provided for moving the crank-pin from the center and thus giving the connecting-rods a variable movement, which, being transmitted through the roller ratchets, gives the rear wheels a degree of angular motion for each stroke of the engine dependent upon the distance the crank-pin is moved from the center. The engine may run all the time at the uniform speed of about 400 revolutions per minute. When the crank-pin is on the center, no movement is communicated to the ratchets, consequently none to the wheels. From this it is obvious that no clutch is required in the construction, aside from that provided by the roller ratchets themselves, since the engine can be started without load by simply moving the crank-pin to the center of its throw, which is always done.

The accompanying diagram, Figs. 1, 2, and 3, give an idea of the construction of the variable-speed gear. The crank-pin *H*, is shown in the center of the flywheel, in which position no motion is transmitted. The dotted lines show the relative positions of the parts when it is moved off the center to the position indicated by *H'*. Two of the connecting-rods, *A* and *B*, transmit the power longitudinally to the arms of the ratchets, *E* and *G*. The third rod, *D*, acts as a lever, having its pivot near its center. The short link *C* connects one end to the crank and the link C_1 connects the other end to the arm *F* of the third ratchet. The diagram shows the rollers *K* of the ratchets, in their neutral position, that is, no engagement is possible to drive in either direction. They are held in this position and the driving positions by means of a bronze cage *L*, which contains 60 slots for the rollers, of which there are 20 in each ratchet, all lying in the same longitudinal grooves cut in the hardened steel center piece, *I*.

The center piece *I* is securely keyed to the sleeve *M*, which is mounted on the axle *O*. The bronze cage is loosely fitted on the steel center and rotates with it, being carried along by the two keys *N N*. These keys may be moved longitudinally, from the driver's seat, and when so moved a spiral feather on top of each, advances or moves back the cage, depending on whether a forward or backward motion is required. Movement in either direction throws the rollers in position to be gripped by movement of *J* in one direction and to release in the opposite direction, thus acting as ratchets having teeth of any desired pitch.

The rollers are made of tool-steel, hardened, are ⅝ inch in diameter and project above and below the cage about 1-16 inch, so as to be gripped between the ring *J* and the grooved center *I*. The longitudinal grooves are about ⅛ inch deep by ¾ wide at the base, with the sides flaring to a width of 1⅜ at the periphery. The sides are ground to an angle of about 10 degrees, varying with the diameter of the center. All the rollers take their proportionate share of the load so the pressure on each one is not great. Four years of use have demonstrated that the outer rings and rollers wear round, the seats in *I* alone requiring regrinding every six months or every year, according to the amount of work done.

The diagram shown in Fig. 3 shows the travel of the crank-pin and the portions of its travel during which each ratchet is in action. The arc designated *a* indicates the distance through which motion is imparted by the working stroke of the upper rod *A; b*, that of the rod *B;* and *c*, that of rod *D*. The single-hatched portions of the diagram indicate the parts of the travel where one rod alone is driving and the cross-hatched portions are those portions of the travel where two rods are working together, or rather where their work overlaps, one releasing while the other is beginning to drive. Thus there is no point at which the rear axle is not receiving motion from the engine, and motion of a quite uniform character being a fair approximation to straight line, when plotted.

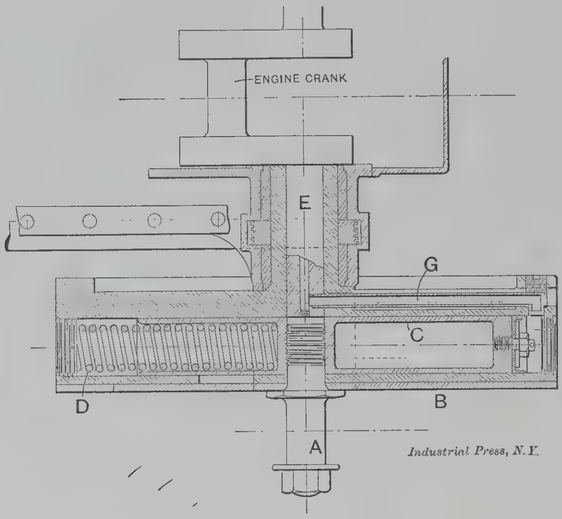


Fig. 4. Section of Flywheel showing Hydraulically Operated Crank-pin.

Fig. 4 shows the construction of the flywheel by which the crank-pin is moved to and from the center. The pin *A* is screwed into a hydraulic piston *C*, which moves in a cylinder bored in the flywheel parallel to its face and passing through the center. The movement of this piston is resisted by the coiled spring *D*, which returns it and the crank-pin to the center when pressure behind the piston is removed. The oil by which it is operated, is pumped into the space *F*, reaching it by means of a hole that passes through the whole length of the crankshaft, cranks and all, and terminates at a stuffing box on the opposite end. A small pump driven from the engine by gearing forces the fluid behind the piston when thrown into engagement by the driver. Normally this pump is out of engagement. The movement communicated to the crank-pin is comparatively slow, so that the acceleration cannot be suddenly increased when starting. After the required throw has been obtained the piston remains oil-locked in position. To stop, the driver pulls a lever which opens a small valve, and allows the crank-pin to move quickly or slowly to the center by the action of coiled spring *D;* a further movement opens a large valve which allows the crank-pin to move quickly to the center; and still further movement of the lever applies a powerful band brake on the differential gear frame.

The running gear of one of these trucks is shown in Fig. 5, from the flywheel side of the engine. The photograph was taken with the crank-pin in the center of the wheel. The three connecting-rods and ratchets are shown; also the differential gear on the further side next to the rear wheel. Motion is conveyed to the bevel gear frame carrying the bevel pinions in the center, by means of a sleeve supported by the shaft *O*, Fig. 1, and attached to the central portion of the differential. From this, motion is communicated back through the shaft or axle *O* to the driving wheel on the side of Fig. 5 toward the reader, and directly to the wheel on the opposite side by means of the bevel gear being attached to the wheel hub itself. The axle is projected through this wheel so as to form its support but not to drive it.

* * *

SHORT RULE FOR COMPUTING SAFE FLYWHEEL REVOLUTIONS.

Wm. H. Boehm gives the following short rule in the Monthly Bulletin of the Fidelity and Casualty Co. for computing the safe number of revolutions for a flywheel.

The rule is based upon the current practice of allowing a rim-speed of one mile per minute for well-made cast-iron wheels, and so does not take into consideration the difference in strength between solid and sectional wheels.

Rule: To compute the maximum allowable number of revolutions per minute for cast-iron wheels, when given the diameter of the wheel in feet. *Divide the number* 1680 *by the diameter.* This is expressed in the form of a formula as follows:

$$\text{Maximum revolutions per minute} = \frac{1680}{D}$$

Example: What is the maximum allowable number of revolutions per minute for a well-made cast-iron wheel 16 feet in diameter? Here we have

$$\text{Maximum revs., per minute} = \frac{1680}{16} = 105.$$

That is, a 16-foot cast-iron wheel should never be run faster than 105 revolutions per minute.

* * *

One of the brightest and best of the English mechanical publications that come to our desk, is *Page's Magazine*, now in its second year of publication. It is not insular in its policy and because of its liberality in publishing foreign mechanical news, especially that from the United States, the publishers say it has been accused of being an American publication. "This is doubtless due to the singular fact that kindred publications which have attained to prominence on this side of the Atlantic have been, for the most part, of American origin, being edited and printed in the United States, shipped over here without covers to escape the imprint 'Made in America,' bound up with English advertisements, and circulated as home publications."

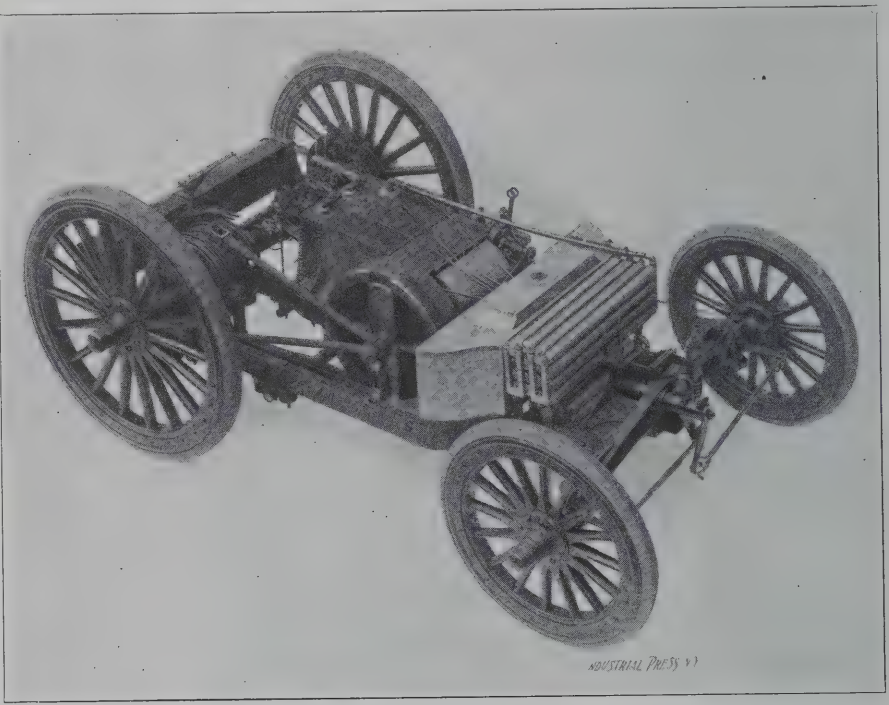


Fig. 5. Running Gear of Union Motor Truck.

LOCOMOTIVE DRIVING WHEEL LATHE WITH SPECIAL FEATURES.

A few months ago James K. Cullen, president of the Niles Tool Works Co., read a paper before the Western Railway Club, in which he referred at some length to a locomotive driving wheel lathe having certain new features, which was built by his branch of the Niles-Bement-Pond Co. for the Altoona shops of the Pennsylvania Railroad. The new lathe, which is thought to mark a considerable advance in this class of railway shop tools, is illustrated in Fig. 1, and details of the magnetic clutch—an important feature of the design—is shown in Fig. 2.

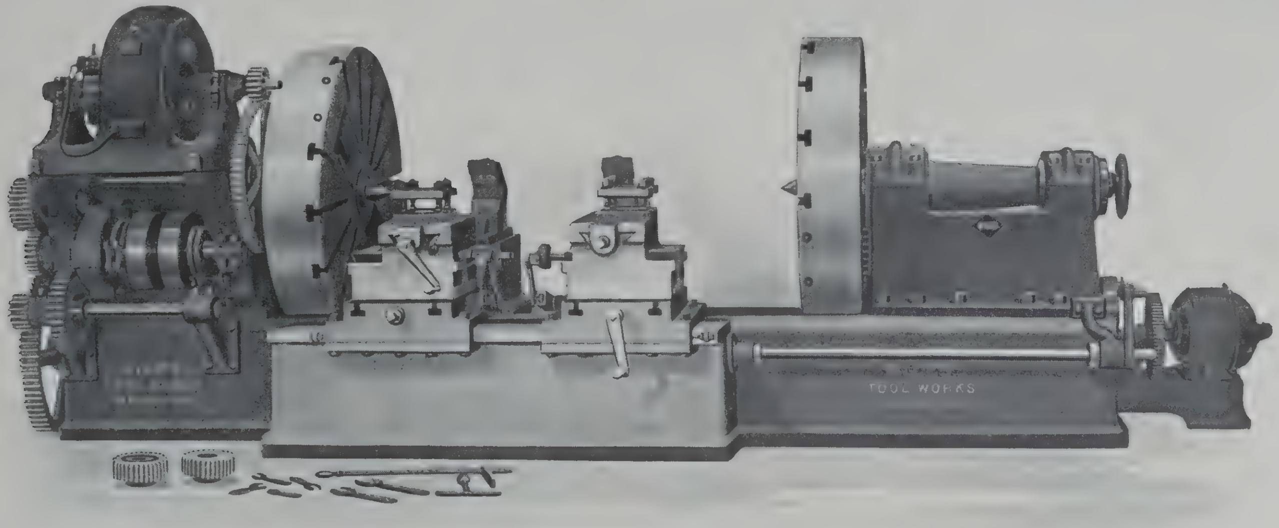


Fig. 1. New Driving Wheel Lathe having Important Improvements.

The lathe was designed to accomplish the maximum output of turned tires now possible with the new high-speed steels. To secure this result, it is necessary to have a much heavier and stiffer construction than heretofore employed in this class of machines; also to provide a more powerful drive and means for instantly reducing the speed to a very slow rate when cutting out "hard spots." One cause for lack of rigidity in the common driving wheel lathe, is the overhang of the internal sliding spindles necessary on account of the crank-pins. To overcome this fault a feature of construction was adopted that would scarcely be feasible without using an auxiliary motor to move the headstock back and forth along the bed, and that is, providing openings in the faceplates for the crank-pins. In this way short centers close up to the faceplates can be used instead of having a long overhang of the internal spindles, as is usual. This construction, of course, makes it necessary to move the right-hand headstock, whenever a pair of wheels is put in and taken out of the lathe, which is done by the 3 horse power auxiliary motor shown at the right. The motor makes the movement of the headstock necessary to clear the crank-pins an easy matter. The final adjustment of the center is made by the internal spindles in the headstocks operated by hand-wheels in the usual manner.

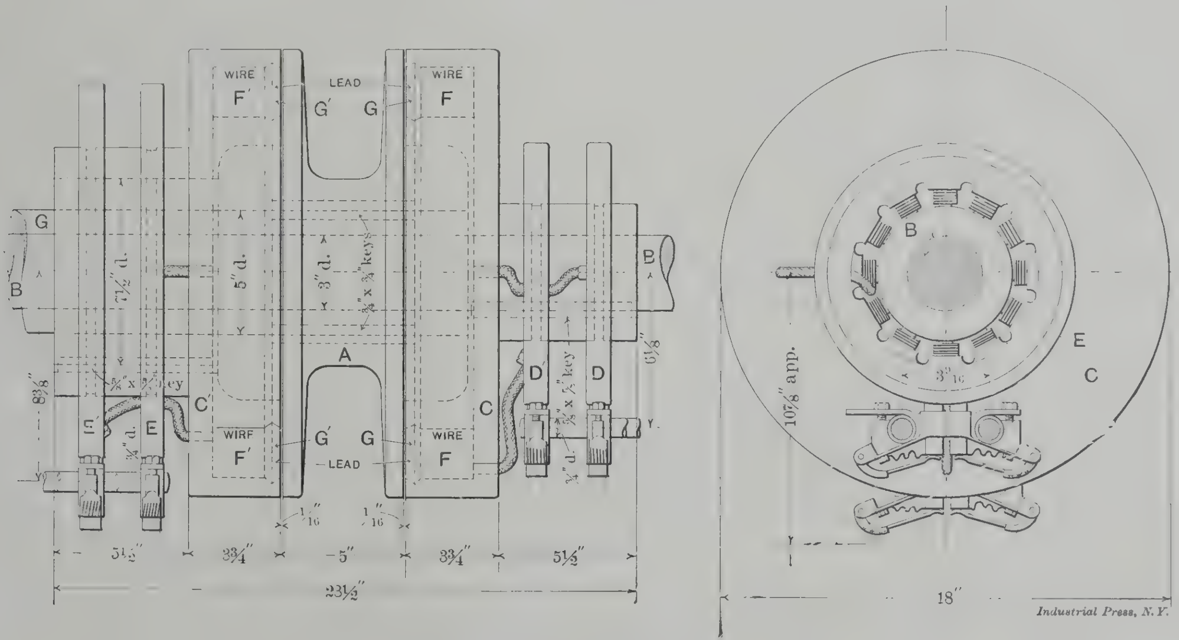


Fig. 2. Details of Magnetic Clutch.

The lathe is driven by a General Electric 25 horse power motor mounted on top of the left-hand headstock. The motor has a range of speed from 600 to 840 rotations per minute and this variation, together with the change gearing that can be introduced in the train of gearing between the motor and the pinions meshing into the internally-geared faceplates gives ordinarily a range of peripheral speed at the tire surface, of 10 to 30 feet per minute. Power is conveyed from the motor to the faceplates, through the magnetic clutch shown beneath the motor in Fig. 1 and in detail in Fig. 2. The object of this device is to provide means for instantly reducing the cutting speed from the normal down to from 4 to 6 inches per minute, depending on the speed of the motor. This slow speed is employed to cut out the hard spots that are developed by skidding tires, etc.

The magnetic clutch by which this great change of speed is effected, consists principally of the spool-shaped steel piece *A* and the two magnets *F* and *F'*. The latter are made with annular grooves for the magnet wire, and the grooves are undercut near the faces for lead filling, *G* and *G'*. The lead filling holds the magnet wire in place and also prevents the faces of the armature A and the magnets coming intimately in contact, which precaution appears necessary to prevent sticking due to "residual magnetism." Otherwise a quick change of the armature from one magnet to the other could not be effected easily. DD' and EE' are collector rings for conveying current to the magnet terminals. Normally the lathe is driven through the magnetic clutch medium with A (keyed to the quill G) attracted to the right against clutch C, which is keyed to shaft B. To reduce to the very slow speed, the left-hand magnet C' is energized by the operator simply throwing a switch, and the armature is attracted to it. The drive is then through the bevel gears seen beneath the motor, and a worm gear, the worm-wheel (covered by the casing) being mounted on the hub of C'. In this way the speed is reduced and at the same time the pressure developed on the tools is enormously increased—two conditions necessary for successfully cutting hardened steel.

Each tool rest can carry two tools and the design of the lathe is such that a pressure of 18,000 pounds can be developed at each tool rest. All gears are made of gun iron and steel. The main spindle bearings are 13 inches diameter and 16 inches long. The internal sliding spindles, 7 inches diameter, are made from steel forgings. The faceplates are 72 inches diameter and have internal gears of 2 inches circumferential pitch. The total weight of the machine is about 80,000 pounds.

* * *

LIGHTNING CLOSES DOWN NIAGARA FALLS POWER PLANT.

(Special Correspondence.)

The most disastrous accident which has ever happened to the Niagara Falls Power Co.'s plant, interfering with its transmission of power to Buffalo and the surrounding towns, occurred Thursday evening, January 29th. An electric storm passed over Western New York, with heavy thunder and lightning, the temperature being high, and yet within a few hours a snow storm followed with a corresponding lowering of the temperature.

The lightning struck a local 2,200 volts line of the Niagara Falls power plant, forming a short-circuit in the cable bridge through which all of the conductors are carried, connecting the 5,000 horse power generators in the power house with the static step-up transformers in the transformer house across the canal. The roofing of the cable bridge and the transformer house being of wood was instantly on fire and all of the cables crossing the bridge were totally destroyed, shutting down the entire plant of 50,000 to 75,000 horse power.

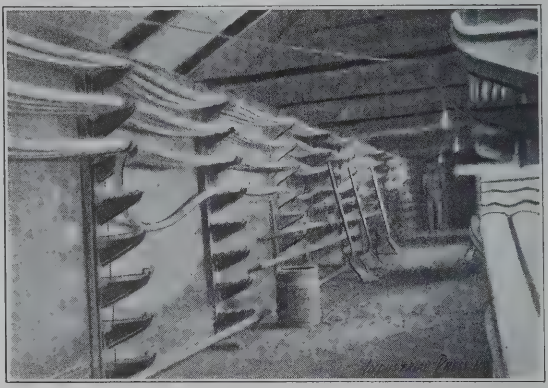
The new power house has five 5,000 horse power generators in place and in operation, but the temporary connections made with the transformer house were interfered with by the fire, resulting in a complete closing down of the generators. In extinguishing the fire large quantities of water were poured into the transformer house, completely deluging the static air cooled transformers and making them useless, until they could be thoroughly dried out.

Fortunately, there was a large stock of high tension lead-covered cable on hand, which was being used for the new power house work, and this was immediately pressed into service. Superintendent Philip P. Barton and his engineers were soon at work, and before morning thirty-six new cables were in place and a new roof was constructed for the transformer house and bridge, and four 5,000 horse power alternators were placed in operation.

It will undoubtedly be some time before the entire plant is in perfect working order again, but most of the power users were supplied with current before Friday night. Probably no other accident could be imagined which would so completely disable the entire Niagara power plant as the burning out of the cables in the bridge conducting the current to the transformer house from the ten 5,000-horse power generators in power house No. 1.

The accompanying photograph shows the interior of the transformer house and conductor bridge with its new roof and cables in place the morning after the fire, with 20,000 horse power being generated in the two power houses. While this was a most satisfactory piece of emergency work, it might have been impossible to accomplish had the new cable not been ready for the new power house construction, although it is stated a large stock of this highly insulated lead-covered cable is constantly kept on hand.

It was of course a most serious matter for many of the users of Niagara power, as many of them operate their plants day and night, and a shut-down of even a few hours is very disastrous. This is particularly so in reference to many of the electro-chemical plants using electric furnaces, and also of factories where many men are employed. The power plant of the Niagara Falls Hydraulic and Mfg. Co., which obtains its power from a surface canal through the city of Niagara Falls, was able to give great assistance during this serious trouble, to local users.



View of Tunnel after Fire, showing Burned Timbers, New Roof and New Cables

The original power house with its 50,000 horse power and the five new generators already installed of 25,000 horse power capacity in power house No. 2, make a total of 75,000 horse power available when the full plant is in operation. This power is not only used for lighting Niagara Falls, Tonawanda and Buffalo, but it also practically operates all the railways in Western New York, as well as a large proportion of the electro-chemical works and factories on the Niagara frontier.

The street railways service and the lighting service of the city of Buffalo were greatly affected by the accident at the power plant. The large storage batteries of several thousand horse power hours' capacity carried the load for a short time, but they were soon exhausted under the heavy discharge. The street railway storage battery was utilized until the large reserve steam plant could be placed in operation, but the car service was badly crippled until the Niagara power was again ready for transmission, although the car lines were never entirely shut down.

The Cataract Power and Conduit Co., however, were not so fortunate as to have a steam plant available, and they could furnish no current to their customers. The Buffalo General Electric Co., and many of the manufacturers were unable to get power until late Friday, which caused much inconvenience. For this reason many of the newspapers were unable to operate their presses, and the three newspapers having reserve steam power, the News, Express and Commercial, aided the Times, Courier and Enquirer.

The fifteen 5,000 horse power generators, and all of the apparatus of both power houses No. 1 and No. 2 are in perfect condition, the reports to the contrary notwithstanding, and only a very small proportion of the static step-up transformers were damaged in any way by fire or water. The lightning did not strike the high tension lines of 22,000 volts, but the damage was confined to the 2,200 volts cables connecting the transformer house and power house No. 1.

This disastrous fire at the Niagara power house shows how much care should be taken with the apparatus for protection against lightning and the desirability of using fireproof materials exclusively in every portion of an electric plant. The duplicating of transmission lines is now extensively practiced and is undoubtedly advisable, and unquestionably engineers of the new Niagara power plants on both sides of the river will consider the causes of this serious shut-down in all their phases and endeavor to make such an accident impossible in the future.

As the other power stations are installed the liability of a complete shut-down will become less and less, as power may be transferred from one power house to the other. The unexpected happened in this case, and there is little liability it will ever happen again. A second conductor bridge with duplicate cable would have rendered the accident less troublesome, as "all the eggs would not have been in one basket" and the current could have been conducted to the transformer house through the duplicate sets of cables. It is also questioned by some prominent engineers whether it is desirable that all of the transformers of a 50,000 horse power plant should be placed in a single building, as the burning out of one set of transformers may affect many others.—F. C. P.

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THE DATA SHEET FOR THIS MONTH.

The data sheet accompanying this month's issue of Machinery presents a diagram for designing band brakes that was computed by Mr. C. F. Blake, Muskegon, Mich. The directions accompanying this sheet adapt it for use in designing band brakes having arcs of contact from 20 to 300 degrees. The diagram, as prepared, considers the coefficient of friction as equal to 0.3, while the table of directions supplies formulas for calculating the desired quantities with any coefficient.

Assuming a problem to illustrate the use of the chart, let us suppose a force $P = 1,800$ pounds is to be held by the brake, having an arc of contact of 180 degrees; coefficient of friction of .3; length of arm $b = 4$ inches and force applied by the operator $= 128$ pounds; what is the required length of the arm a?

Starting at 1,800 pounds under $f = .3$, follow up to the 180 degree line, thence to the right to the line representing $b = 4$ inches, thence down, meeting the horizontal line from 128 pounds on line representing $a = 36$ inches. This will be the length required. Looking in the column headed T_1 we read 1,150 pounds, which is the pull upon the loose end of the strap. This multiplied by $k = 2.56$, obtained from the table opposite 180 degrees and under $f = .3$, will give T_2 the pull upon the tight end of the strap as 2,944 pounds.

Upon the third page of the sheet is a diagram for determining the weight of cast iron pulleys. This diagram was prepared, and the formulas deduced, by Mr. William Sangster, Jamaica Plains, Mass., and is the result of an investigation of a very large number of pulleys of acceptable design. The lines are the result of two factors—one a constant for each diameter and the other a factor of diameter and face. It may readily be seen that an equation, probably varying as the square of the diameter, would give the weight of arms as a constant for each diameter of pulley, and this equation is expressed by

$$.0362\ D^2 - 2.$$

The rims on the larger pulleys are thicker than those on the smaller ones, and the equation

$$.0175\ D^{1.87} + 3.$$

gives the weight of rim for each inch of width. D in each of these equations represents the diameter of the pulley in inches. The combined equations

$$.0362\ D^2 - 2 + (.0175\ D^{1.87} + 3)\ W.$$

where $W =$ face of pulley in inches, will be found to be fairly accurate for estimating pulleys from 10 to 42 inches in diameter. Pulleys under 10 inches in diameter easily vary from 100 to 200 per cent. in weight, owing to the various sizes of shafts with their corresponding diameters of hubs, so that the diagram and formulas are not to be used for close approximations for pulleys under 10 inches in diameter.

The table of geometrical progression which appeared in the February number of Machinery has been put into data sheet form, for the convenience of the draftsman and designer, and forms the fourth page of the sheet for this month.

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Radium, the curious and wonderful element which seems to possess intrinsic energy and emits light without loss of energy, so far as discovered—the next thing to perpetual motion—sells at the rate of $900,000 a pound, although we do not know that there is so large a quantity as this available at the present time. If it is true, however, that its energy is inexhaustible and as a substance it is indestructible, it would be cheap at any price, considered as an investment.

THE EFFICIENCY OF MECHANISM.*

WITH SPECIAL REFERENCE TO HOISTING MACHINERY.

C. F. Blake.

When undertaking the development of any machine the designer is promptly brought to face the question of the probable efficiency of the mechanism he wishes to employ. If the machine belongs to a class with which the designer has been long familiar, he may be able to judge closely from past experience as to what efficiency to assume in his present calculations. If the designer cannot bring to his aid such past experience, he may be told by the chief engineer to assume a particular value for the efficiency. Failing in both past experience and the availability of the chief engineer, the designer may attempt a wild guess, more or less remote from actual conditions, possibly seeking information from a handbook, where he may find something like the following, from D. A. Low's Pocket-book for Engineers:

Mechanical efficiency of machines.

P = force acting at the driving point,

W = force acting at the working point,

r = velocity ratio of the machine, $= \dfrac{\text{velocity of working point}}{\text{velocity of driving point}}$

p = value of P when $W = O$,

e = a coefficient,

E = mechanical efficiency of the machine.

When friction is neglected $\dfrac{P}{W} = r$,

when friction is taken into account $P = (1 + e)\ Wr + p$.

For a particular machine the preceding equation reduces to $P = mW + k$, where m and k are constants determined from experiments with the machine.

$$E = \frac{W r}{(1 + e)\ W r + p} = \frac{W r}{m w + k}$$

This is exceedingly disappointing, as the inconvenience of experimenting with a particular machine yet unbuilt, with a view of determining constants to be used in calculations during its design, is apparent. Consequently the aforesaid wild guess is too often used as a basis from which to calculate the probable performance of the machine.

The determination of the efficiency of any elementary portion of a machine by analysis is a comparatively simple matter, and by roughly dividing the proposed machine into several such elementary portions, and determining by analysis the efficiency of each element, the approximate efficiency of the whole machine may be determined. The following analysis of some simple portions of machinery may easily be extended by the application of the same reasoning to other cases, and the tables may form a guide for an intelligent guess which will come nearer the truth than a wild guess.

Efficiency Defined.

The force exerted to run any kind of machine is used in the performance of two functions: To perform the intended useful work for which the machine is designed; and to overcome the frictional resistances in the several parts of the machine. If the machine could be considered as running with absolutely no frictional resistance between its moving parts, we should have the product of force into space moved equal to the product of load into space moved; or

$$P_1\, s = L\, h, \quad P_1 = \frac{L\, h}{s} \ldots\ldots\ldots\ldots\ldots (1)$$

in which $P_1 =$ the theoretical force, which acting through a space s, will move a load L a certain distance h, under the assumption that there are no frictional resistances in the machine.

The force exerted through the space s, must, however, overcome the frictional resistances within the machine, as well as the resistance of the load L through the distance h. Let $W =$

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* This article will be completed in two installments, of which this is the first. The present installment considers the efficiency of simple pulleys and sheaves and of ropes, with a discussion of general principles. The concluding installment will take up the efficiency of tackle, gears, winding drums and finally a complete hoisting apparatus, which will include the various elements previously treated.—Editor.

the sum of all the frictional resistances within the machine, and w = the sum of all the distances through which the several frictional resistances are overcome. Then Ww = the work done in overcoming the frictional resistances of the several parts of the machine. The actual force, acting through a space s, besides being required to move the load a distance h, must in addition be sufficient to overcome the frictional resistances within the machine itself; so the actual effort required to move the load is,

$$P\,s = L\,h + W\,w, \text{ or } P = \frac{L\,h + W\,w}{s} \;\ldots\ldots (2)$$

Thus from (1) and (2) it is seen that the actual force P must be greater than the theoretical force P_1.

The ratio of the theoretical to the actual force is termed the efficiency of the machine; thus

$$e = \frac{P_1}{P}$$

As has been seen, P is always greater than P_1, and it follows that the efficiency of any machine being always less than unity, represents the percentage of the force exerted which is actually employed in moving the load. The use of this ratio expressing the efficiency is of the greatest value in practical problems relating to the force required to run any given machine; as, in the most complicated cases, the theoretical force

$$P_1 = \frac{L\,h}{s}$$

in which the three factors L, h, and s, are known for each particular case. Thus a knowledge of the efficiency e of the particular machine under consideration enables the designer to determine at once the force required for the particular case, as

$$e = \frac{P_1}{P}, \text{ and } P = \frac{P_1}{e}$$

The value of e for any machine is easily computed when the efficiencies of the several moving parts are known. Let e_1, e_2, e_3 — — — e_n be the efficiencies of the several moving parts of the machine; then the efficiency of the whole machine is,

$$e = e_1 \times e_2 \times e_3 \times \;-\;-\;-\; e_n \ldots\ldots\ldots\ldots (3)$$

Since the moving parts of most machinery may be reduced to a few classes or heads, a knowledge of the average values of the efficiency of each class will, in all cases, enable the designer to arrive at results sufficiently accurate for practical purposes.

In the preceding discussion it has been assumed that the force P acts in a direction to move the load forward, and that the frictional resistances act against the force P, in the same direction as the load L. The relation of power to load and frictional resistances is well illustrated in the case of a crane; and such a machine will hereafter be used in the discussion, it being understood that what is said applies as well to any class of machinery.

Efficiency of Backward Motion.

When a crane is at rest with a load L suspended, the force P is being exerted to maintain the load in suspension, and prevent it running down. In this case the frictional resistances within the machine are acting in the same direction as P, and usually the work Ww done in overcoming them is the same for the backward as for the forward motion; while L becomes the actuating force, and P acts as a retarding force to prevent acceleration when lowering the load.

Thus when the load is being lowered we have,

$$L\,h = P\,s + W\,w, \text{ or } P = \frac{L\,h - W\,w}{s} \;\ldots\ldots (3)$$

while as before we have

$$P_1 = \frac{L\,h}{s} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

which clearly indicates that when lowering the load, the force P, which must act to prevent acceleration, is less than the theoretical force P_1. By the efficiency of a machine for the backward motion is understood the ratio of the actual force required to prevent acceleration when lowering the load, to the theoretical force required to effect the same result could the frictional resistances within the machine be neglected.

Thus for backward motion,

$$e = \frac{P}{P_1}$$

Substituting in this equation the values of P and P_1 in (3) and (4) we have,

$$e = \frac{\dfrac{L\,h - W\,w}{s}}{\dfrac{L\,h}{s}} = \frac{L\,h - W\,w}{L\,h}$$

from which we see that when $Ww = Lh$, $e = 0$, and the internal forces of frictional resistance and L are balanced without the application of P; also when Ww is greater than Lh, e has a negative value, and an additional force P acting in the same direction as L, must be applied at the point of application of the power in order to lower the load.

A negative value for e on the backward motion may therefore be taken as an indication that the load will remain suspended upon the removal of the motive power. This is a feature especially to be desired in all cranes as a safety device for those operating them. It is, however, often obtained by the sacrifice of high efficiency on the forward movement. For the forward motion we had

$$e = \frac{P_1}{P}$$

and substituting in this equation the values of P_1 and P from (1) and (2) we have,

$$e = \frac{\dfrac{L\,h}{s}}{\dfrac{L\,h + W\,w}{s}} = \frac{L\,h}{L\,h + W\,w}$$

which, under the assumption that the work done in overcoming the frictional resistances within the machine is the same for both forward and backward motion, and assuming the limiting case $Ww = Lh$, becomes

$$e = \frac{L\,h}{L\,h + L\,h} = \frac{1}{2}$$

Thus the efficiency for the forward motion of all elementary self-locking machines which automatically sustain the load, never exceeds 50 per cent., while for cases where n is negative the efficiency, is less than 50 per cent.

This statement is true for all elements in machine design intended to be used as power transmission elements for the forward movement, while being expected, from the nature of the design, to resist all backward impulses due to the load when the power is removed. It is possible, however, by the introduction of devices which, being idle during the forward movement, are called into action by the slightest backward movement of the parts to which they are attached, and which, being so put into action, present additional frictional resistances acting in the direction of the force P, to design a machine of any given efficiency for the forward movement, which will automatically sustain the load when the power is removed.

Rigidity of Ropes.

When considering the efficiency of the different classes of mechanism combining to form a hoisting machine, it will be seen that the resistance of ropes to bending around sheaves and drums enters largely into the equations for the efficiency of these parts. Any rope offers resistance, by reason of its rigidity, when wound onto a sheave or drum, while by reason of its elasticity, little or no resistance is offered when it unwinds and passes off the sheave or drum.

In Fig. 1 let T = the tension in the *on* side of the rope about to be wound around a sheave, and $T + T_1$ = the tension in the *off* side of the rope; then T_1 = the force required to bend the rope around the sheave while under the tension T. Let R_1 = the radius of the sheave, and d = the diameter of the rope, while $r =$ the radius of the rope $= \frac{d}{2}$

Then let $R_1 + r = R$.

The lever arm of the rope axis on the *off* side is,

$$bc = R_1 + r = R.$$

Considering the *on* side of the rope, the fibers on the outside are stretched, while those on the inside are compressed, and the resultant of these two forces with the force T will lie to the outside of the rope axis—a distance denoted by h.

Then the lever arm of the *on* side is

$$ab = R_1 + e + r + h = R + e + h.$$

The distance e is given by DuBois as

$$e = \frac{k}{T}, \text{ for hemp rope and}$$

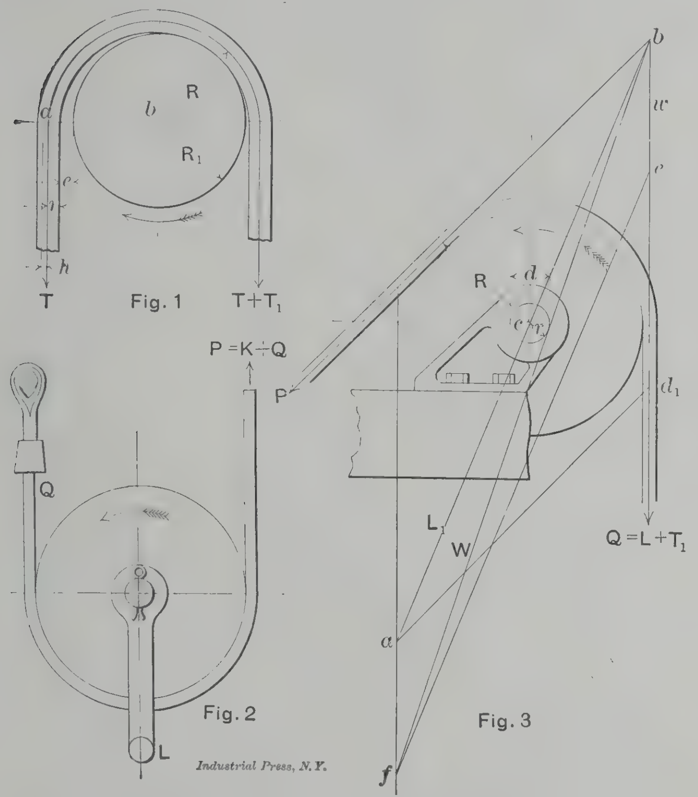
$$e = \frac{k\,R}{T} \text{ for wire ropes,}$$

where k is a constant to be determined by experiment.

The condition for equilibrium is then

$$T\left(R + \frac{k\,R}{T} + h\right) = (T + T_1)\,R, \text{ or } T_1 = k + \frac{T\,h}{R}$$

Experiment gives this formula the form,



Efficiency of Ropes and Fixed and Movable Pulleys.

$$T_1 = 1.08 + \frac{0.09\,T}{R} \text{ for wire ropes,}$$

$$T_1 = \frac{100 + 0.22\,T}{R} \text{ for tarred hemp rope,}$$

$$T_1 = \frac{4 + 0.065\,T}{R} \text{ for untarred hemp rope,}$$

where T and T_1 are expressed in pounds, and R in inches. (DuBois.)

The efficiency of the rope, neglecting the journal friction of the sheave, is

$$e = \frac{T}{T + T_1}$$

Example: A one-inch wire rope under 20,000 pounds tension is wound over a 15-inch sheave. Neglecting the journal friction of the sheave, what force $(T + T_1)$ will be required to raise the load of 20,000 pounds?

Here $T = 20{,}000$.

$R_1 = 7.5$.

$R = 8$.

then, $T_1 = 1.08 + \frac{0.09 \times 20{,}000}{8} = 226.08$ pounds,

and $T + T_1 = 20{,}226.08$ pounds.

The efficiency in this case is

$$e = \frac{T}{T + T_1} = \frac{20{,}000}{20{,}226.08} = .989$$

The following table, No. 1, gives the efficiency of plough steel wire ropes when strained to their full working capacity, and wound over sheaves or upon drums of the smallest diameter that should ever be used with each size of rope. It will be observed that the diameters given in this table are much smaller than those recommended by the rope manufacturers as the minimum to be used with each size of rope. The diameters given here are those in constant use by many of the foremost crane builders, it being found impracticable to use the large sheaves and drums recommended in the space at the disposal of the designers.

TABLE I. EFFICIENCY OF WIRE ROPES.

Diam. of Rope.	Min. Diam of Drum or Sheave under Rope.	Efficiency $e = \frac{T}{T + T_1}$
½	10	.982
⅝	12	.985
¾	14	.987
⅞	16	.989
1	18	.990
1⅛	20	.991
1¼	22	.992
	Average,	.988

The Fixed Pulley.

Let Fig. 3 represent a fixed pulley or rope sheave, over which a rope is passed, by means of which a force P is to lift a load L. The spaces s and h through which P and L move respectively are equal $(s = h)$, hence neglecting all friction and lost power, we have the theoretical force,

$$P_1 = L \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The wasteful resistances to be overcome are: 1st. The stiffness of the rope requiring the additional force T_1, which may be added to the load, making the total force acting in the *on* side of the rope

$$Q = L + T_1, \text{ and}$$

2nd. The journal friction due to the resultant pressure L_1 of P and Q, and the weight w of the sheave.

Produce P and Q to meet at b, and draw bc produced to a. Lay off to any convenient scale $bd_1 = Q$, and draw d_1a parallel to Pb. Then $ab = L_1$, and when measured to scale gives the resultant pressure on the journal due to P and Q. Lay off on bd_1 to the same scale as before, $be = w$, the weight of the sheave. Draw ef parallel to ab, and draw bf. Then $bf = W$, and when measured to scale gives the total pressure W on the journal, due to the resultant of the forces P and Q and the weight w of the sheave.

We now have three forces acting, P, Q, and W, of which Q and W are acting in the same direction, opposed to P, and as the distances through which these forces move are proportional to the lever arm in each case, we have the condition of equilibrium, letting the coefficient of journal friction $= \phi$

$$P\,R = Q\,R + W\,r\,\phi$$

$$P = \frac{Q\,R + W\,r\,\phi}{R} \ldots\ldots\ldots\ldots\ldots (2)$$

From (1) and (2) we have the efficiency

$$e = \frac{P_1}{P} = \frac{L\,R}{Q\,R + W\,r\,\phi}$$

In making calculations, we may at first neglect the stiffness of the rope, in which case $Q = L$, and we have the efficiency with the rope neglected,

$$e_1 = \frac{L\,R}{L\,R + W\,r\,\phi}$$

Let $e_2 =$ the efficiency of the rope from the table No. 1. Then we have the efficiency, including the rope,

$$e = e_1 \times e_2.$$

The maximum value of L_1 is reached when P and Q are parallel, and is then $P + Q = L_1$; the weight w of the sheave may be neglected as having little influence upon the efficiency; the rigidity of the rope may be neglected at first and brought into the solution afterwards, as shown above; and $P + Q = 2L$. Then under these assumptions, viz., $W = L_1 = P + Q = 2L$, and $Q = L$, we have by substitution in (2)

$$P = \frac{L\,R + 2\,L\,r\,\phi}{R} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Thus from (1) and (3) we get the minimum efficiency of a fixed sheave, neglecting the weight of the sheave, and letting the efficiency of the rope $= e_2$ as above

$$e = \frac{e_2\,P_1}{P} = \frac{e_2\,L}{\dfrac{L\,R + 2\,L\,r\,\phi}{R}} = \frac{e_2\,R}{R + d\,\phi}$$

The following table, No. 2, gives the minimum efficiency of the smallest diameter of sheave allowable with each size of rope, assuming in each case the load L on the rope to be the full working strength of the rope, the arc of contact to be 180 degrees, the coefficient of journal friction .08, the diameter of journal pin 4 inches, and values of e_2 taken from table No. 1.

TABLE NO. 2. EFFICIENCY OF THE FIXED SHEAVE.

Diam. of Rope.	Diam. Sheave.	e for Rope, Table I.	e for Sheave.	Coeff. of Resistance.
½	10	.982	.925	1.081
⅝	12	.985	.936	1.068
¾	14	.987	.945	1.058
⅞	16	.989	.952	1.050
1	18	.990	.957	1 045
1⅛	20	.991	.961	1.040
1¼	22	.992	.965	1.036
	Average,	.988	.948	1.055

From (3) we have, including the efficiency of the rope e_2,

$$P = \left(\frac{e_2(R + d\,\phi)}{R}\right) L, \text{ and letting}$$

$$\frac{e_2\,(R + \mathrm{d}\,\phi)}{R} = k \text{ we have}$$

$$P = k\,L \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

in which k is the coefficient of resistance of the sheave and rope combined. From (1) and (4) we have,

$$e = \frac{P_1}{P} = \frac{L}{k\,L} = \frac{1}{k} \text{ and}$$

$$k = \frac{1}{e}$$

In the fifth column of the above table the values of k are calculated under the same conditions as are those of e, so that knowing either the power applied, P, or the load to be lifted, L, the other may be easily calculated with sufficient accuracy by the use of the above tabular values in the two equations

$$P = k\,L \text{ and } L = e\,P$$

For the backward motion when the load is descending, we have

$$P = k\,L$$

and

$$L = \frac{P}{k}$$

The distance through which L acts is equal to the distance through which P acts; hence letting s equal this distance, we have the work performed at the point of application of each force, P and L, as

$$P\,s, \text{ and } L\,s = \frac{P\,s}{k}$$

and the efficiency

$$e = \frac{L\,s}{P\,s} = \frac{1}{k}$$

Thus the efficiency of a fixed sheave is the same for the backward as for the forward motion.

Movable Pulley or Sheave.

In the case of movable pulleys or sheaves, Fig. 2, as in pulley blocks, the ropes are always parallel, or nearly so, and letting $Q =$ the tension produced in the *on* side of the rope by the load L, we have

$$P = kQ,$$

and the condition of equilibrium is

$$L = P + Q = Q + kQ = Q(1 + k).$$

To raise the load L a distance s, each end of the rope must be shortened by a distance equal to s, and as the end Q is fixed, this is accomplished by the end P moving upwards a distance equal to $2s$.

The energy exerted is $P \times 2s$, or

$$2kQs,$$

and the useful work performed is Ls, or

$$Qs(1 + k),$$

while the efficiency is

$$e = \frac{Q\,s\,(1 + k)}{2\,k\,Q\,s} = \frac{1 + k}{2\,k}$$

The efficiency of a fixed sheave was shown to be $e = \frac{1}{k}$, and as k is always greater than unity, we see that the efficiency of a movable pulley is greater than that of a fixed pulley.

For the reverse motion, with the load descending, we shall have the tensions in the ends of the rope reversed, and

$$Q = kP,$$

while as before,

$$L = P + Q = P + kP = P\ (1 + k).$$

The energy exerted is

$$Ls = Ps\ (1 + k),$$

while the useful work performed is

$$2ps,$$

and the efficiency is

$$e = \frac{2\,P\,s}{P\,s\,(1 + k)} = \frac{2}{1 + k}$$

for the backward movement.

The following table, No. 3, gives the minimum forward efficiency under the same conditions as for table No. 2:

TABLE NO. 3. EFFICIENCY OF THE MOVABLE PULLEY.

Diam. of Rope.	Diam. Sheave.	Coef. Resistance k.	Efficiency. $e = \frac{1 + k}{2\,k}$
½	10	1.081	.962
⅝	12	1.068	.968
¾	14	1.058	.972
⅞	16	1.050	.976
1	18	1.045	.978
1⅛	20	1.040	.980
1¼	22	1.036	.982
	Average,	1.055	.974

* * *

ELECTRIC FURNACE VS. BLAST FURNACE.

One of the electrical enthusiasts, to whom probably all things seem possible by the use of electricity, has endeavored to show that iron ores can be electrically smelted cheaper than they can be reduced in the ordinary blast furnace. The *Engineering News* cruelly knocks this "pipe dream" in the head—allowing such dreams have heads—in an analysis of the matter published in a recent issue. Mr. Rossi by a marvelous juggling of figures in the *Iron Age* showed that a ton of pig iron manufactured in a blast furnace, would cost $12.47; in an electrical furnace, only $12.15. To secure this result he charges up iron ore to the blast furnace men at the rate of $4.50 per ton. The electrical furnace is supposed to get it for 75 cents a ton. The feature of the matter to be seriously considered, however, is the assumption that electrical energy can be furnished by water power for $10 per year, which, of course, could not be done on a large scale except perhaps at Niagara, Sault Ste. Marie, and some undeveloped water powers in the west. But even allowing that it could be, the investment of capital would be greatly in favor of the blast furnace plant. A blast furnace having a capacity of say 350 tons per day could be erected for $1,000,000 in round figures. An electrical water power plant capable of developing 60,000 horse power is estimated to cost probably five or six times that amount. Such a large investment would be out of the question. The conclusion is that an electric furnace can by no means compete with the blast furnace.

* * *

"Big Ben," the famous clock in the tower of the House of Parliament, London, is regularly wound by hand and it takes two men 12 hours each week to complete the operation. This is the way it is done in England, but it is not the way it would be done in America.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The Farmers' National Bank Building, which is to be the largest structure in Pittsburg, and one of the tallest office buildings in the world, is nearing completion and will be occupied early in March. The entire building is to be lighted with Nernst lamps, made by the Nernst Lamp Company, of Pittsburg. There are to be installed 1,000 55-watt single glower, 1,250 88-watt single glower, 20 two-glower and 20 six-glower lamps, and although different units will prevail in the building, the quality of light will be the same throughout, this being one of the features of Nernst Lamp illumination in distinction from the combination of arc and incandescent lights ordinarily found in large interiors.

A new step in the generation and distribution of power is to be taken at Pittsburg in connection with a new group of office buildings to be erected in the neighborhood of Fifth street and Duquesne Way. One plant will furnish light, heat and power for the entire group of five or six buildings, including the Bessemer building, corner Sixth street and Duquesne Way. The power equipment will include two 1,500 H. P. Westinghouse-Corliss engines, of the horizontal, cross-compound type, running non-condensing, and the exhaust steam will be used for heating purposes. On account of the high river water universally experienced in lower Pittsburg, the engines will be placed upon the ground floor instead of in the basement, while the boilers will be located on the second floor of the plant and supplemented by suitable coal and ash handling appliances.

In connection with its other projected improvements in New York and vicinity, which were already of a stupendous character, the Pennsylvania Railroad has made plans to spend about $10,000,000 additional in securing an all-rail connection with the New York, New Haven & Hartford Railroad. The plan is to build a bridge and viaduct two miles long, the bridge beginning at Port Morris, New York, and crossing to Long Island. The bridge will be built from Port Morris to Randall's Island, thence to Ward's Island, and across Hell Gate to Astoria, Long Island. The span across Hell Gate will be 840 feet long and 135 feet above high tide. The steel for the structure, weighing 61,000,000 pounds, has been ordered from the United States Steel Corporation and will cost something like $3,250,000. A line will be built from the Astoria end of the bridge to connect with the Long Island Railroad and the viaduct at the other end on Manhattan Island will complete the desired connection with the New Haven road.

The steam turbine equipment of the Hartford Electric Light Co., which was the first large installation of the kind in the country and has attracted a great deal of attention among engineers, is to be added to in the near future. The present Corliss engines will be replaced by two 1,000 H. P. turbines, direct-connected to revolving field polyphase generators. These units will operate in parallel with the 1,500 K. W. unit first installed. Superheated steam at 150 pounds pressure will be used. The original turbine at this plant has at one time or another given considerable trouble, owing, we understand, to the facts that opportunity was not afforded to completely test and adjust it at the works, and that the manager of the Hartford plant decided to increase the steam pressure after the wheel was installed, making it necessary to operate the turbine under conditions for which it was not adapted. It is significant that in spite of these difficulties the turbine has proved its worth sufficiently to warrant replacing Corliss engines with additional turbines.

There has been considerable speculation as to the effect of the "tooth of time" on the modern steel frame building popularly known as skyscrapers in New York, so the tearing down of one of these structures in this city has attracted some attention. The building in question was the Pabst Hotel, at the corner of Broadway and Forty-second street, which was erected in 1898 and which had to be torn down to make room for a larger structure to be erected by the New York Rapid Transit Railway for a station. So far as critical examination can show the framework of the building was in perfect condition, but since it had been erected only four years this evidence is not very conclusive. It does show, however, that the agencies that work for deterioration have not made progress in that space of time. The beams and girders were practically all incased in concrete. The tearing down of the frame was the reverse operation of its erection, the rivet heads being knocked off with a set-chisel and sledge and the members lowered by a derrick. All parts were carefully numbered for re-erection.

FLUE DUST BRIQUETTING TO BE TRIED.

In the *Engineering Review* of our January number was a somewhat extended account of the process for briquetting ore dust from blast furnaces. It is now announced that the Jones & Laughlin Co. will make a trial of this system which, if successful, will not only mitigate one of the worst nuisances of an iron and steel plant—the intolerable dust—but will also effect an immense saving. That the briquetted dust is of a quality suitable to use there is no question, but it remains to be proven whether the briquettes are strong enough to withstand the pressure of the ore and coke with which the furnace is charged. It is said that over 13½ per cent. of the fine Mesabi ore used by this company escapes from the blast furnaces in the form of dust, and this is said to mean a loss of over $350,000 a year. It is estimated that if the briquetting system were also used in the oil regions there would be a saving of over $1,000,000 annually on the total shipments of ore, from the fact that as now transported freight must be paid on an immense weight of water with which the ore is saturated. This water would be eliminated in the briquetting process, and, as previously stated, the estimated saving would be $1,000,000, or very much more than would be necessary to cover the expense of briquetting.

MORE ABOUT THE PROPERTIES OF NICKEL STEEL.

Nickel steel alloys in varying proportions have many strange properties. We have already mentioned the very small coefficient of expansion possessed by nickel-steel containing about 36 per cent. nickel, being something like one-thirteenth that of wrought iron. An article by M. Paillot in the Journal of the *Société Industrielle du Nord de la France*, states that the magnetic properties are quite as interesting. An alloy of 25 per cent. nickel with steel, is not magnetic at ordinary temperatures, although its components are strongly so, but when subjected to a very low temperature it becomes magnetic and preserves this state when brought back to the normal temperature. Alloys which generally contain less than 25 per cent. nickel contents, are strongly magnetic under certain conditions, but lose their magnetic property when heated to cherry red and only resume it when cooled to a very low temperature. An alloy containing slightly more than 25 per cent. nickel, is only magnetic at temperatures below the freezing point of water. Some alloys diminish in density by about 2 per cent. by passing into the magnetic state. Again wires made of steel containing 24 per cent. nickel resemble soft brass wires when in the non-magnetic state, but in the magnetic state they become springy as though made of hardened steel.

ELECTRICALLY-EQUIPPED HOUSES.

It is said that the electrical equipment of the reconstructed White House is the most complete to be found in all the country. Elaborate arrangements are provided for lighting the house and grounds effectively during receptions or other state functions, and there are numerous electrical appliances for use in the kitchen, for operating the elevator automatically without the need of an attendant, and for other purposes.

There are two telephone systems—one for the use of the President and his family, and the other for State uses.

While this installation is on a large scale, it is doubtful whether it is more complete than that in the somewhat famous house of Chas. R. Barnes, the New York State electrician, at Rochester, N. Y. Mr. Barnes has made this equipment his hobby, without regard to expense, and he has even gone to the extravagance of heating his house by electricity. The heaters are controlled from a single switchboard in the library, and a unique feature that must appeal to any lazy man is that the heat may be turned on without the sleeper having to venture from the protection of the warm coverlets.

In the kitchen are electric cooking devices—including an oven for baking—and less necessary but very desirable arrangements, such as electric chafing dishes and what is called an electro-therm, which is a flexible pad heated by electricity and used like a hot-water bottle. The lighting system is very complete, there are electric fans in every room, and last Christmas a tree was decorated with 600 incandescent lamps. This electrical installation may possibly be the forerunner of what is in store for the most humble householder a few years hence.

NEW PRESIDENT OF STEVENS INSTITUTE.

On February 5th, Mr. Alexander C. Humphreys was inaugurated as president of Stevens Institute of Technology, Hoboken, N. J. The ceremonies consisted of exercises with addresses by leading educators and other prominent men, with a reception in Carnegie laboratory, Stevens Institute, and an alumni dinner at Sherry's, New York. The new president, in his address, outlined his views of technical education, contending that the competent engineer should not only be trained in mathematics, mechanics, physics, etc., but in certain broadening subjects such as English, logic, history, modern languages, economics, and business methods. Upon the latter he laid especial stress, and said, "It is not enough that the technically trained engineer should be practical in the shop and in the field; he must be practical in his ability to meet business men on their own ground. Some engineers fail to secure success because they carry too large a proportion of science; some because they have not enough, and others because they fail to recognize that commercial efficiency must outweigh theoretical efficiency. The training of the engineer must be a harmonious blend of science, practice, and commercial judgment."

Mr. Humphreys has long been identified with Stevens Institute as a member of the Trustees and was practically the unanimous choice of trustees, faculty, students and alumni for the office of president. He was born in 1851 in Scotland and when he came to this country began life in the insurance business and later was connected with the Bayonne and Greenville Gaslight Co., Bayonne, N. J., finally becoming their general superintendent. At this time he was desirous of securing a technical education and made arrangements to take lectures at Stevens Institute in connection with his regular duties at Bayonne. He distinguished himself in his studies in spite of the restricted time that could be devoted to the course of study, and graduated with such honors that a special vote of commendation was passed by the faculty of the institute—an unprecedented recognition. Mr. Humphreys has devoted his life to the engineering of gas plants and for several years held the position of superintendent of the United Gas Improvement Co. of Philadelphia. Ultimately he was connected with the sales and other commercial departments of the business, giving special attention to the development of the water-gas branch of the business, of which he made a specialty. In 1894 he resigned from this company and established the firm of Humphreys & Glasgow, consulting engineers, London, with offices also in New York, making a specialty of water gas. Mr. Humphreys at one time or another has been the chief executive of over 50 gas and electric companies and in all his work has been distinguished by rare executive ability.

A DUST-PROOF BUILDING.

There is one building in Pittsburg from which smoke and soot are excluded and whose occupants do not have to wonder whether their lungs are slowly becoming carbonized. It is perhaps the only smokeless and dustless spot in the city. This building, according to the Pittsburg *Leader*, is the one containing the offices of the Pittsburg & Lake Erie Railroad. The windows and doors are made to fit as tightly as possible, the former even being packed with felt to exclude the dust, and the whole interior of the structure is supplied with pure air by an elaborate ventilating system which maintains a pressure in the building slightly in excess of atmospheric pressure. The air enters through an intake on the roof and passes directly to the basement, where it goes through a chamber fitted with hot water heaters used in winter to partially warm the air and prevent freezing of the apparatus. From this it passes through a washer or spray room in which is a system of water jets for precipitating the dust in the air, and it finally passes by a series of baffles or sheet iron plates, which are intended to catch the surplus moisture in the air. The air is again heated and driven through ducts into the various offices by a large fan, which fan also serves to draw the air down the intake from the roof. A second series of baffles has also been installed to reduce the humidity of the air as much as possible and their application seems to be reasonably successful, since we are informed that even in summer weather the air is not moist enough to be uncomfortable. The air enters the rooms through grated openings in the ceiling, to which deflectors are applied to dissipate the current. Other grated openings near the floor connect with a duct leading to a suction fan on the roof. It is evident that circulating a large quantity of air in the condition in which it is found in Pittsburg would ordinarily result in coating everything with black soot in a short time, but it is said that papers or books left standing for weeks in this building remain clean and show no indication of the smoke that is so annoying everywhere else in the city.

In other respects also the building is modern, as for example in the supply of ice water, which is delivered to all parts of the building by a pipe system. The water is distilled by an independent plant, and is kept circulating in the pipes, so that it is not necessary to let the water run before using.

ELECTRICAL VS. COAL CAR TRANSMISSION.

The *Electrical World and Engineer* discusses editorially the electrical transmission of energy vs. coal car transmission. In Colorado the comparison between these two methods has been more actively considered than in any other locality. The cost of hauling coal in a level country by modern railroad methods seems to be so low that the cost of a transmission line with the fixed charges thereon will wipe out any advantage to be gained from using the coal directly at the mines and transmitting the power. In the mountains of Western Colorado, however, there are cases where there is no question as to the economy of transmitting at high voltage rather than hauling fuel to the station from some inaccessible mine. In the Cripple Creek district conditions are such as almost to balance the two methods. In this latter district can be found power transmitted 26 miles at high voltage from a plant located near the coal mines, and also power supplied from a plant in the district. In this case the country is mountainous. But that there is little difference between the cost of power when transmitted and the cost when generated in the district, is shown by the fact that engineers of national reputation have been responsible for the building of both types of plants. Farther east in Colorado, at Denver and Colorado Springs, where the country is comparatively level, nearly every large generating plant that has been built during the past few years, has been erected only after a careful consideration of the ultimate cost of power from a plant located at the coal mines as compared with a plant located in the city. Coal is found near both Colorado Springs and Denver. So far, however, only one plant has been built at any considerable distance from a city for the purpose of getting its coal at the mines.

But the cost of coal transportation is not the only thing to be considered in this connection. Skilled labor of the kind necessary to operate a large generating plant, can be obtained at the mines only at a much higher rate than if the plant were located in more congenial surroundings. Mining communities are likely to be lonely places for a man who is skilled in power house operation; and if the right kind of men are to be kept there, they must be paid for staying. Furthermore, it is frequently figured that if the station is located at the mine, it is for the purpose of utilizing the slack and coal dust that would not be shipped because of its low grade. If this kind of fuel is used, it requires a large boiler capacity per kilowatt, because in practical operation there is always the possibility that a poor streak of fuel will get into the furnace about the time the heaviest load comes on. To provide for such emergencies, the boiler capacity provided must be larger than would otherwise be necessary. Hence, in view of these considerations, it is safe to assume that in a level country the high-voltage transmission line as a competitor of a railroad cannot show a saving.

THE MODERN BATTLESHIP.

World's Work. February, 1903.

An English writer has recently described a battleship as the "last word that mechanical genius, naval construction and cash payment can say in aggressiveness." From the fighting-top to double bottom, from ram to sternpost, she is the most complicated machine the mind of man ever conceived. There is scarcely a trade or an art that is not represented in her building. She is a house that must be lighted, ventilated, drained, and painted. She is a fort that must carry guns of heaviest calibers for fighting other battleships; guns of medium size for piercing the comparatively thin protection of armored cruisers; scores of rapid-firers for protecting herself against torpedo boats, and even a battery of small Colts for picking off sharpshooters and exposed men. Above all, she is also a ship to be taken to sea, to make passages from port to port and long ocean voyages. Moreover, she is a hostelry in which there are 700 men who must be clothed, fed and housed, and for whose use there is provided an ice plant having a capacity of three tons of ice per day and evaporators that daily produce 16,000 gallons of fresh water; there is also a bakery and an enormous kitchen for cooking. Besides the ponderous main engines of say 16,000 horse power there are perhaps nearly one hundred auxiliary engines or about the same number of electric motors. The boilers, with their 46,000 square feet of heating surface, must not be forgotten, nor the coal bunkers, which, in the Oregon, for instance, have a capacity sufficient to steam that vessel a distance of 5,500 miles without recoaling.

NEW METHOD OF TESTING WIRE.

Abstract from Paper read by Arthur Falkenau before the Engineers' Club, November, 1902.

In a paper read before the Engineers' Club of Philadelphia by Arthur Falkenau, November 1, 1902, a new method and machine for testing wire were described. The author says that plow steel wire rope, is or should be the best for any purpose. The term "plow steel" refers to wire having a tensile strength of 200,000 pounds per square inch and even higher. The wire for ropes for all sizes from 2½ inches diameter to the smallest, should be uniformly graded in strength from 200,000 to 275,000 pounds per square inch approximately. But it does not follow that wire of this high strength will necessarily show a reduced number of bends received in testing; on the contrary if the wire is made from good quality of stock and properly treated the number of bends should be increased. The ability to resist bending stresses, is, of course, the principal limiting factor in the life of wire ropes, as the most serious wear comes from the constant bending around sheave wheels or drums. Wire must be selected that will stand the greatest number of bends through an angle of not less than 90 degrees under a load uniformly proportionate to the ultimate strength of each test specimen. Of course this load must be below the elastic limit. If this plan is followed it is not necessary to consider either the torsional or elongation test, simply because wire rope is not subject to either of these strains when installed.

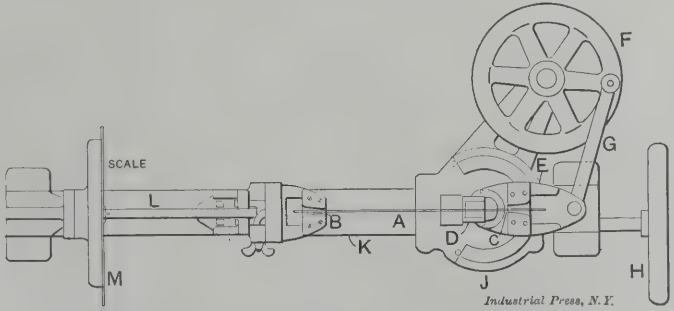


Fig. 1. Plan of Machine for Testing Wire.

The machine for making the bending tests is shown in diagram by Fig. 1. The specimen of wire, *A*, is introduced into the grips *B* and *C* and passed between the hardened steel blocks at *D*. For a tensile test, turn the handwheel *H*, which screws the head *J* out along the bed *K*, producing a tensile stress in the wire which is transmitted through the lever *L* to the scale *M*, which is shown on edge. The bending test is made by applying the desired initial load by means of the handwheel *H*, then rotating the handwheel *F*, which swings the arm *E* by means of the connecting-rod *G* and bends the wire about the hardened steel blocks at *D*.

This machine has shown that the old method of bending test, is unreliable. By the old method, low carbon steel or double-worked refined iron even may be made to show more bends than the best plow steel. But if the test is made under the same conditions, subjecting each specimen to a load of, say, one-fourth its ultimate strength, as can be readily done in this machine, the plow steel will at once show its superiority for rope.

THE COOPER-HEWITT ELECTRIC MERCURY LAMP, AND STATIONARY CONVERTER.

Engineering (London), January 16, 1903, p. 82.

The remarkable mercury vapor lamps devised by Mr. Peter Cooper-Hewitt are now being exhibited at the offices of the Westinghouse Company, Norfolk street, Strand. These lamps can be run off any ordinary continuous-current electric light supply system, and show an efficiency of 3.3 candles per watt, (5 candles per watt is 100 per cent. efficiency), or for the same lighting require only about one-ninth the current taken by ordinary incandescent. The sole drawback to the light lies in its extraordinary color. There is a total absence of all red rays, and consequently all tints red by ordinary light are curiously perverted. A lady's lips look purple; so that at present no attempt is being made to utilize the light for domestic purposes, as feminine opposition would be too strong. In other cases, however, the light has very great advantages. It is stated that it is an excellent light to work by, and this we can well believe. The light comes from a tube about 1 inch in diameter and about 3 feet long, and this tube is filled with a continuous glow from end to end. No portion of it has the painful brightness of a glow-lamp filament, and it is possible without discomfort, to gaze directly at a tube yielding a light of 700 candle-power. The light-giving vapor being so voluminous, there are no sharp shadows; a fact which is of great importance in the lighting of warehouses and factories. The light is, moreover, highly actinic, and can be used advantageously for printing ordinary photographs or blue prints.

The lamp consists of an exhausted glass tube having a bulb at one end. This bulb contains a little liquid mercury in which is immersed a platinum electrode, which passes through the glass, and is connected to the negative terminal of the supply system. At the other end of the tube is a second platinum wire, which is coupled up to the positive main, and inside the glass has attached onto it a fragment of iron which forms the positive electrode. The bulb at the other end of the tube is covered externally with a conductive coating, which is connected up to the positive side of the supply. This coating and the mercury inside the bulb constitute, therefore, a small condenser which is of use in starting the lamp. Once the lamp is started, it is sufficient to maintain a difference of 85 volts between the terminals. The whole tube is then filled with mercury vapor which has a temperature of between 3,600 degrees and 5,400 degrees F. This vapor is continually condensing on the cold walls of the containing glass, whence it finds its way back into the bulb, to be evaporated afresh. The amount in the state of vapor at any time is, however, extremely small, and consequently the glass does not get really hot, nor is the light obstructed by the portion condensed on the interior surface of the tube. A much higher potential is required to start the lamp than to run it. This starting potential is obtained very simply by means of a compound switch. This switch has two circuit-closers, one of which opens and closes the main circuit through the lamp, while the other throws in or out of circuit a coil of large self-induction, arranged in parallel with the lamp. In starting, the switch for the lamp circuit is first closed; but, owing to the high resistance of the lamp, no current flows. The second switch is then moved round; this first closes the circuit through the induction coil, and then breaks it. The spark on discharge has no path open to it, save through the lamp. It accordingly goes that way, breaking down its resistance, and the current can then be maintained through the lamp by a potential of only some 85 volts. The action of the induction coil is reinforced by the condenser formed between the mercury and the outer coating of the lamp bulb, as above described. Two or more lamps can be run in series. The sizes made range from 16 candle-power up to 10,000. The former has a tube 3 inches long by ⅛ inch in diameter and the latter a tube 12 feet long by 3 inches in diameter. The voltage can be adjusted within wide limits, since the resistance of the column of mercury vapor varies directly with its length and inversely with its diameter. The latter point is curious, and may, perhaps, be due to the column of vapor being hollow.

The lamps are used only on continuous-current circuits, since a current can pass through them in one direction only. This fact has been applied to the production of a rectifier for altering currents now being developed by the Westinghouse Company, the device being known as the "Hewitt static converter." In this arrangement a vacuum tube or bulb containing only mercury vapor is fitted with a positive electrode for each phase of an alternating current, but has a single negative electrode only. As the current can pass in one direction only, a unidirectional current is obtained. Converters on this plan may be used for all voltages between 100 and 1,000 volts, and for all capacities up to 100 amperes. The efficiency is very high, the sole loss being the constant drop of 14 volts in the bulb. Hence with a 100-volt system the efficiency is 86 per cent., but with a 1,000-volt supply it is 98.6 per cent. The apparatus is cheap, and requires no more attention than an ordinary transformer.

THE CONDITIONS NECESSARY FOR SUCCESSFUL COAL DUST BURNING.

Abstract from Paper read before the Indiana Engineering Society by F. A. W. Davis.

On account of the following advantages possessed by coal-dust fuel as enumerated by Mr. Davis, vice-president of the Indianapolis Water Company, that concern installed a plant costing some $25,000 for the purpose of manufacturing coal-dust fuel for their power plant:

1. Cleanliness of the boiler room.
2. Use of coal screenings (much of which now goes to waste).
3. Perfect combustion of 80 per cent. of the coal.
4. Reduction of the cost of coal for fuel, and the number of employees to handle it.
5. Ready facilities for increasing the heat quickly, consequently the capacity of a boiler plant. (To many concerns this is important.)
6. Lessening the quantity of coal wasted with the ashes.
7. Lessening the quantity of ashes to be handled.
8. Smoke prevention, a most desirable condition anywhere.

The machinery installed by the water company for producing powdered coal has a capacity of 140 tons in twenty-four hours, and is as follows:

1. Cylindrical rotary drier through which all the slack coal is passed. The moisture must be taken out of all coal before it goes to the grinding machinery, otherwise it is impossible to grind it to the satisfactory degree of fineness.
2. Rotary ball mill into which the coal is delivered from the drier. This is a drum 5 feet 6 inches diameter, and 3 feet 6 inches long inside, revolving at 22 revolutions per minute. This drum is partially filled with steel balls, which reduce the coal to 8 mesh, that is, so it will pass through a screen of 8 meshes to one inch.
3. The rotary tube mill which receives the coal from the rotary ball mill. This mill is a cylinder 4 feet diameter inside and 20 feet long, lined with buhrstones, such as used in flouring mill work, and is filled about one-half full of pebbles brought from Greenland (none being found in this country that will do the work). The cylinder revolves at the rate of about 25 revolutions per minute, and it reduces the coal to about 100 mesh. The tube mill requires 60 horse power to drive it; the ball mill, 18 horse power; and the drier, 8 horse power.

Mr. Davis thinks, as the result of the knowledge and experience gained with this plant, that one of the secrets of successful coal-dust burning is in grinding the coal almost as fine as flour, so that it will be consumed while suspended in the blast. This means that part of the ashes will be unavoidably carried into the tubes and there cause loss of heat unless means are provided for their removal. He concludes that the chief difficulties to be overcome in successful coal-dust burning, are:

1. Grinding the coal to the proper degree of fineness.
2. Regulating the quantity of dust required to produce the heat; also the quantity of air and its pressure to burn it.
3. The proper construction of the furnace.

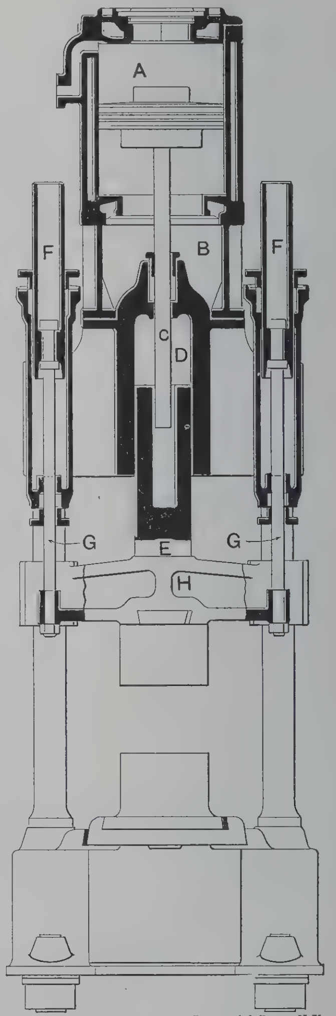
HYDRAULIC FORGING PRESS.

Zeitschrift fur Werkzengmachinen und Werkzenge. December 5, 1902. p. 99.

A forging press whose construction is shown in the accompanying engraving has been recently built by Haniel & Lueg at Dusseldorf, Germany. The press itself consists of a simple hydraulic cylinder, with a steam cylinder placed above it as the source of power, and is attached to the press itself by means of steel connections *B*. The piston rod that runs down from the steam piston forms the ram for the cylinder *D* of the press. By means of the difference in the diameters of the steam pistons and this plunger a pressure of about 6,000 pounds per square inch is exerted by the head *E* of the press upon the material to be worked. The development of the hydraulic pressure and its transference to the ram head of the machine take place in the same chamber. There are, therefore, neither the valves nor the piping that are usually found where high pressures are to be used.

The lifting of the head, after accomplishing its work, is effected by means of two pistons *FF*, which are under constant pressure of about 750 pounds and whose piston rods *GG* take hold of the four corners of the head of the press. As soon as the steam pistons are relieved of the pressure upon them the withdrawing cylinders lift the head and draw it back to its uppermost position.

The speed of this press is dependent upon the speed with which steam can be admitted to and exhausted from the upper cylinder, and this can be done at the rate of from thirty to forty times a minute.—G. L. F.



Industrial Press, N. Y.

Fig. 2. Hydraulic Forging Press.

THE CUTTING ANGLES OF TOOLS.

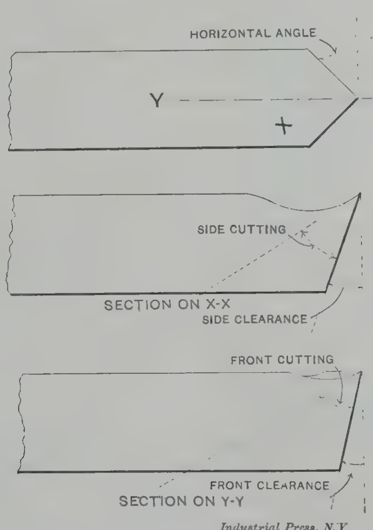
Abstract from Paper read before the Institution of Mechanical Engineers by H. F. Donaldson, January 16, 1903.

The author gave an account of tests made under his direction at Woolwich to determine the best angles for lathe tools made of the new high-speed, self-hardening steels. He first laid down the conditions, that, what a tool will do depends upon: 1. The material of which it is made. 2. The nature of the material to be worked. 3. The speed it is to work at. 4. The depth of cut. 5. The width of feed. A diagram was introduced in the paper, Fig. 3, to make clear what he meant by the cutting and clearance angles of tools. The top and side pressures on the tool were determined by a simple apparatus mounted on the tool-holder by means of which the pressure was transmitted hydraulically to ordinary pressure gages. The tool was balanced on a knife edge and the factor of leverage multiplied by the indicated pressure gave the actual pressure.

TABLE I.—SHOWING BEST RESULTS IN OPERATING ANGLES OF TOOLS.

Material, Index No., and Degree of Hardness.	Diameter.		Speed of Material.		Speed of Tool.			Tools and Angles.						Lubricant Used.	State of Tool-edge after Work.			Shavings.		Surface of Specimen After Work		
	Before.	After.	Revolutions per minute.	Feet per minute.	Feed.	Travel.	Time.	Nature of Tool.	Front Cutting.	Side Cutting.	Front Clearance.	Side Clearance.	Horizontal.		Not Damaged.	Slightly Damaged.	Completely Damaged	Long.	Short.	Smooth.	Rough.	Very Rough.
	ins.	ins.			in.	ins.	mins	inch.	deg.	deg.	deg.	deg.	deg.									
I. Steel HHH.	3.4	3.2	18	15	$\frac{1}{40}$	3	6.75	1 C.S.	75	69	2	2	33	Soda Hyd.	. .	Yes	. .	. .	Yes	Good	. .	. .
II. Steel H.	1.85	1.7	70	32	$\frac{1}{70}$	6	6	"	59	62½	3	3	33	"	. .	Yes	. .	Yes	. .	"	. .	. .
III. Steel HHN.	5.75	4.95	18	27	$\frac{1}{60}$	3	9	"	62½	62½	1	1	32	Do. and Soap.	. .	Rough on Edge	. .	. .	Yes	"	. .	. .
IV. C. Steel HH.	6	5.15	18	25	$\frac{1}{40}$	1	2.25	"	65	63	2½	1	42	"	. .	"	. .	Long	. .	"	. .	. .
V. Steel HH.	1.5	1.25	70	27½	$\frac{1}{61}$	1	0.44	"	62½	62½	3	3	42	"	Not	. . .	. .	Yes	. .	"	. .	. .
VI. Steel H.	8.35	7.5	5½	12	$\frac{1}{8}$	10	15	1¼ M	55	52	4	5	35	"	Not	. . .	. .	Yes	. .	"	. .	. .
VII. Steel HO.	6.75	6.25	5½	10	$\frac{1}{14}$	18	44	"	57½	55	8	8	40	"	Not	. . .	. .	Yes	. .	"	. .	. .
VIII. W. Iron M.	3	2.75	70	55	$\frac{1}{70}$	2	2	1 C.S.	57½	55	3	3	42	"	Not	. . .	. .	Yes	. .	"	. .	. .
IX. C. Iron	4.95	4.3	18	21	$\frac{1}{27}$	2	3	"	60	64	1¼	1	35	Nil	. .	Yes	. .	. .	Yes	"	. .	. .
X. G.M.F. HH.	3.37	3	140	122	0.02	4	1.45	"	61	64	3	0	35	Soda Hyd.	Not	. . .	. .	Yes	. .	"	. .	. .
	3	2.7	320	251	0.03	6	0.6	"	61	64	3	0	35		Not	. . .	. .	Yes	. .	"	. .	. .
XI. G. Metal M.	2.6	2.37	320	217	0.03	6	0.6	"	73	74	2	5	35	"	Not	. . .	. .	. .	Yes	"	. .	. .
XII. G. Metal S.	3.5	3.25	320	293	0.03	5	0.5	"	73	74	2	5	35	Nil	No.	. . .	. .	. .	Yes	"	. .	. .
XIII. G. Metal F. HH.	2.65	2.45	224	160	0.02	4	0.75	"	78	78	1	0	35	Soda Hyd.	Not	. . .	. .	. .	Yes	"	. .	. .
XIV. G. Metal F. H.	2.4	2.125	224	140	0.02	3	0.55	"	62½	64	3	3	35	"	Not	. . .	. . .	Yes	. .	"	. .	. .

* Very hard material indicated HHH.
Medium hard material indicated HH.
Hard material indicated H.
Oil-hardened material indicated O.
Medium material indicated M.
Soft material indicated S.
Forged material indicated F.
Nickel Material indicated N.



Industrial Press, N.Y.

Fig. 3. Illustrating Cutting Angles of Tools.

In one test in which the pressure on the tool was determined for different depths of cut, a pointed tool like that shown in the diagram, Fig. 3, was used, having a front cutting angle of 60 degrees; front clearance, 5 degrees; side cutting, 60 degrees; side clearance, 5 degrees; and horizontal angle, 40 degrees. In this trial medium hard steel at a speed of 14.65 feet per minute, feed 1-32 inch, depth of cut 0.1 inch, developed a pressure of 81.25 pounds on top of the tool. With the same speed, but a feed of 1-20 inch and a depth of cut of 0.125, the pressure increased to double or 162.5 pounds, being directly proportional to the cross-section of the cut in this case.

TABLE II. LIMITS OF CUTTING ANGLES.

	Front Cutting.	Side Cutting.	Front Clearance.	Side Clearance.	Horizontal.
	deg.	deg.	deg.	deg	deg.
For cutting mild steel . .	52 to 60	50 to 60	3 to 8	3 to 8	33 to 43
For cutting medium steel	54 to 63	60 to 65	3 to 8	3 to 8	33 to 43
For cutting hard steel . .	65 to 78	60 to 70	3 to 8	3 to 8	33 to 43
For cutting soft yellow metal	62 to 74	62 to 74	3 to 8	3 to 8	33 to 38
For cutting medium yellow metal	62 to 74	70 to 75	3 to 8	3 to 8	33 to 38
For cutting hard yellow metal	60 to 80	60 to 80	3 to 8	3 to 8	33 to 38

While the author found that a sharp-pointed tool gave the least resistances, he admits, of course, that in actual work the rounded nose tool is the best. It is stronger, and having more metal takes the heat slower, and gets rid of it quicker. He condemns spring tools, laying great stress on the necessity for absolute stiffness and rigidity in the tool and its support. In all the tests the top of the tool was set slightly above the center of the work, the amount varying, of course, with the diameter. He finds that the ruling factor in fixing cutting angles, must in all cases depend, to a large extent, upon the hardness of the metal to be worked; the harder the metal the more obtuse the angle. In Table I are tabulated the best results in operating angles of lathe tools. The lubricant was not flooded on, but was only dropped in small quantities.

In Table II the author gives what he considers to be limits of cutting angles. The discussion following the reading of the paper indicated a keen interest in the subject, and the criticism was of a very intelligent character. The full paper and discussion may be found in *Engineering*, date January 23, to which we are indebted.

THE YEARLY COST OF ONE STEAM HORSE POWER.

Engineer, February 2, 1903. p. 145.

Wm. O. Webber says that there is misunderstanding in regard to the cost of steam horse power. While it is true that the cost per horse power in the larger plants developing 1,000 to 1,500 horse power may be from $22 to $26 per year, it is by no means true that these figures hold for smaller plants. Mr. Webber has had occasion in the last few years to make up the figures on the cost of a number of small power plants. From these figures he has made up the accompanying table:

COST OF ONE HORSE-POWER PER ANNUM.

Ten-hour basis, 308 days per annum.

Size of plant, H. P.	100	200	300	400	500	600	700	800	900	1,000	1,500	2,000
Cost of plant, per H. P.	$170.00	$146.00	$126.00	$110.00	$96 00	$85.00	$76.00	$69 00	$64.00	$60.00	$58.00	$56.00
Fixed Charges at 14%	$23.80	$24.40	$17 65	$15.40	$13.45	$11.90	$10.65	$9.65	$8.95	$8.40	$8.12	$7.85
Coal per H. P. H., pounds	7.0	6.5	6.0	5.5	5 0	4.5	4.0	3.5	3.0	2.5	2.0	1.5
Cost of fuel at $4 per ton	$38.50	$35.70	$33.00	$32.00	$27.50	$24.70	$22.00	$19.20	$16.50	$13.75	$11.00	$8.25
Attendance 10-hour basis	12.00	10.00	8.60	7.25	6.20	5.40	4.70	4.15	3.75	3.50	3.25	3.00
Oil, waste, supplies	2.40	2.00	1.72	1.45	1 24	1.08	0.94	0.83	0.75	0.70	0.65	0.60
Total, coal $4.00 per ton	76.70	68.10	60.97	56.10	48 39	43.08	38.29	33.83	29.95	26.35	23.02	19.70
With coal at $5.00 per ton	86.40	77.10	69.22	61.90	55.29	49.28	43.79	39.73	34.05	29.80	25 77	21.75
With coal at $4.50 per ton	81.50	72 60	65.07	58.10	51.79	46.18	41.04	36 28	32.00	28.05	24.39	20.72
With coal at $4 00 per ton	76.70	68.10	60.97	56.10	48.39	43.08	38.09	33.83	29.95	26.35	23.02	19.70
With coal at $3.50 per ton	71.90	63.70	56.82	50.50	45.04	39.98	35.54	31.48	27.87	24.60	21.64	18.67
With coal at $3 00 per ton	67.00	59.20	51.67	46.70	41.49	36.88	32.79	29.03	25.80	22.90	20.27	17.65
With coal at $2.50 per ton	62.30	54.75	48.59	43.00	38.83	33.83	30.04	27.18	23.75	21.20	18 89	16.60
With coal at $2.00 per ton	57.45	50.25	44.47	40.10	34.64	30.73	27.29	24.23	21.70	19.47	17.52	15.57

In this table it will be seen that, while a 1,000 horse power installation of boilers, engines, buildings, chimney, and all accessories, costs about $60 a horse power, the same installation for 300 horse power costs at least double per horse power. It has been found by these figures that the interest on the first charges should be 14 per cent., of which interest is 6 per cent., depreciation 4 per cent., repairs 2 per cent., insurance 1 per cent., and taxes 1 per cent. It will also be noted in this table that, while for a 1,000 horse power installation the coal necessary per horse power per hour for the main engine, pumps, condensers, etc., is only 2½ pounds, on a small plant of 300 horse power at least 6 pounds of coal must be allowed for these same purposes. The cost of fuel is given at $4 per ton, that being considered a fair average price, delivered on the fire room floor.

The attendance varies very largely with the size of the plant. In a 1,000 horse power plant, three men in the boiler room during the day at $1 50 a day, and one night man at $1.50 would be only $1.85 per horse power. One engineer at $3 per day and an assistant at $2 per day would only be $1.54 per horse power. However, $3.50 is allowed for attendants, instead of $3.39, which this would amount to. On the other hand, in a 100 horse power plant an engineer at $2.50 a day would be $7.72 per horse power, and a fireman at $1.50 a day would be $4.62 a horse power, amounting to a little over $12. In this case the amount is called $12, and the attendance for the other amounts of power is proportioned in a ratio which would apply to the different sizes of powers and numbers of attendants required.

The cost of oil, waste, and supplies is also similarly proportioned, and the results check very closely with those found in average practice; also the figures given by such authority as Dr. Charles E. Emery, of New York, who makes the cost of a horse power with a simple low speed non-condensing engine, with coal at $4 a ton, about $76. De Courcey May gives a corresponding figure of $57, but this is known to be too low. Dr. Emery gives the cost of a horse power in a low speed condensing engine, with coal at $4 a ton, about $56, which would be a close check on the 400 horse power plant, where surely a condensing engine would be used. De Courcey May gives the corresponding figures as $33, which is considered to be too low for so small an engine as 400 horse power, though approximately correct for an engine as large as 700 or 800 horse power. On the larger engines, which would be either triple expansion, or compounds with a ratio of expansion corresponding to a triple, the figures of $23 for a 1,500 horse power engine check very closely.

Some little time ago, Mr. Webber averaged the figures of a number of estimates made by several different authorities, with the following results, 100 horse power, $63; 200 horse power, $45; 300 horse power, $37; 400 horse power, $32; 500 horse power, $29; 600 horse power, $28; 700 horse power, $27; 800 horse power, $26; 900 horse power, $25; 1,000 horse power, $24; 1,500 horse power, $22; 2,000 horse power, $21.

These figures he believes to be correct for the larger horse powers, but are too low for the smaller powers, principally because these have been based on mill plants, where better types of engines prevail, and more attention is given to economical administration.

A WATER WHEEL FLOW RECORDER.

Abstract of Paper read before the meeting of the A. S. M. E., January 26, 1903, by Prof. C. M. Allen.

The recorder is designed for use where water power is sold by large companies to individual users, as at Holyoke and Lowell, Mass. In order to apply the machine the wheel for which it is to register must be tested so that the flow at various gate openings and heads is known. A curve is then plotted between gate opening with gate openings as vertical ordinates, and head as horizontal, and this diagram—wrapped around a cylinder—is used as one boundary of a toothed surface, the other of which is the vertical axis of gate openings. At the bottom of the cylinder this toothed surface will come to a point, and at the top will nearly surround the cylinder, as seen at *a*. The grooved surface meshes with a small gear at the side of the cylinder, seen at *b*. This gear turns the shaft *c* by means of a feather, and the shaft, in turn, by means of the gear *d* at the top, rotates the upper drum.

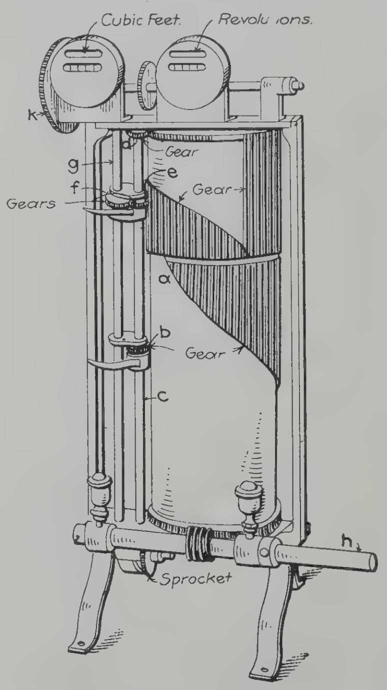


Fig. 4. Register for Flow of Water.

On the upper drum the curve bounding the toothed surface is plotted between flow and head, hence is a square root curve; and this surface engages an idler gear *e* on the shaft *c*, which meshes with a gear *f*, driving the shaft *g* by a feather.

The shaft *g* moves the register wheels by means of bevel gears, as in the ordinary water meter.

The lower drum is driven by a screw gear on the shaft *h*, which is belted to the water wheel shaft.

The vertical position of gear *b* is controlled by a sprocket chain and wheel *k*, and varies with the gate opening, the lowest position corresponding to closed gate, and the highest to full gate. The gears *e* and *f*, on the same carriage, are controlled by the head acting on the wheel, being at the bottom of the drum when the head is greatest.

The revolution counter is connected by sprocket and shaft to shaft *h* and records the revolutions of the turbine.

The lower cylinder, in one revolution turns the gear *b* a number of revolutions proportional to its distance from the bottom, hence proportional to the gate opening, and the upper cylinder, which is driven by *b*, also turns in proportion to the gate opening. The upper cylinder, in one revolution turns the gear *e* a number of revolutions proportional to its distance from the top, hence depending on the head. The record is therefore varied as the head and the gate opening vary.

If so desired, the curve of the upper cylinder may be plotted proportional to the $\frac{3}{2}$ power of the head, in which case the register will read in power developed instead of flow.

Recorders have been in use for about two years, giving entire satisfaction, and have shown on careful test against a Venturi meter and a standard weir a maximum error of 3 per cent. and a minimum of less than 1 per cent.—A. L. R.

LARGE STEAM TURBINE INSTALLATION.

Steam Engineering, February, 1903, p. 252.

The Massachusetts Electric Companies, controlling about 900 miles of street railways, have contracted with the General Electric Company for ten 3,000 horse power and three 1,000 horse power steam turbines of the Curtis vertical type direct-connected to electric generators, making an aggregate of 33,000 horse power. Mr. C. F. Bancroft, chief engineer of the Massachusetts Electric Companies, states that the ten 3,000 horse power turbines will be installed in three stations superseding thirteen of the engine-driven stations now operated by the companies. At present the lines south of Boston, comprising about 380 miles of track and designated as the Old Colony Division, are operated from eleven separate stations, distributed irregularly over the territory served. Nine of these will be displaced by two steam turbine central stations, one aggregating 9,000 horse power, located at Fall River, and one of 12,000 horse power capacity at Quincy Point. The lines north of Boston, known as the Boston & Northern Division, comprise about 455 miles of electric railway track, and are now operated from ten separate power stations. Five of these power houses will be displaced by one steam turbine station, aggregating 9,000 horse power, located at Danvers, Mass. The three 1,000 horse power steam turbines mentioned are intended for a small combined lighting and electric railway power house at Newport, R. I., which is also under the control of the Massachusetts Electric Companies.

The steam turbines, which, as stated, are of the Curtis vertical type, will run at the very low speed of 750 revolutions per minute, taking steam at 175 pounds pressure at the turbine nozzle. In each unit the generator is mounted on the upper end of the turbine shaft without the interposition of reducing gears of any kind. Alternating current of 13,000 volts, three-phase and 25 cycles per second, will be generated. Each of the larger turbines will be 12 feet diameter at the base, 19 feet high and will weigh approximately 190,000 pounds.

The Newport station plans provide for four 1,000 horse power Curtis vertical turbines, of which three are now being installed. The boiler room is to be fitted with equipment for supplying superheated steam on the Schmidt system, which may be used or not at will, the intention being to carefully experiment and note the action of the turbines with both saturated and superheated steam. Four 350 horse power Aultman & Taylor water-tube boilers, fitted with Green economizers, will be installed at first. The separately-fired superheater stands at one end of the line of boilers, and the arrangement of the steam piping is such that steam can be taken through the superheater or direct from the boilers.

The annexed elevation, Fig. 5, shows one of these 1,000 horse power turbines and gives the principal dimensions. It will be noted that the engine room floor level is above the

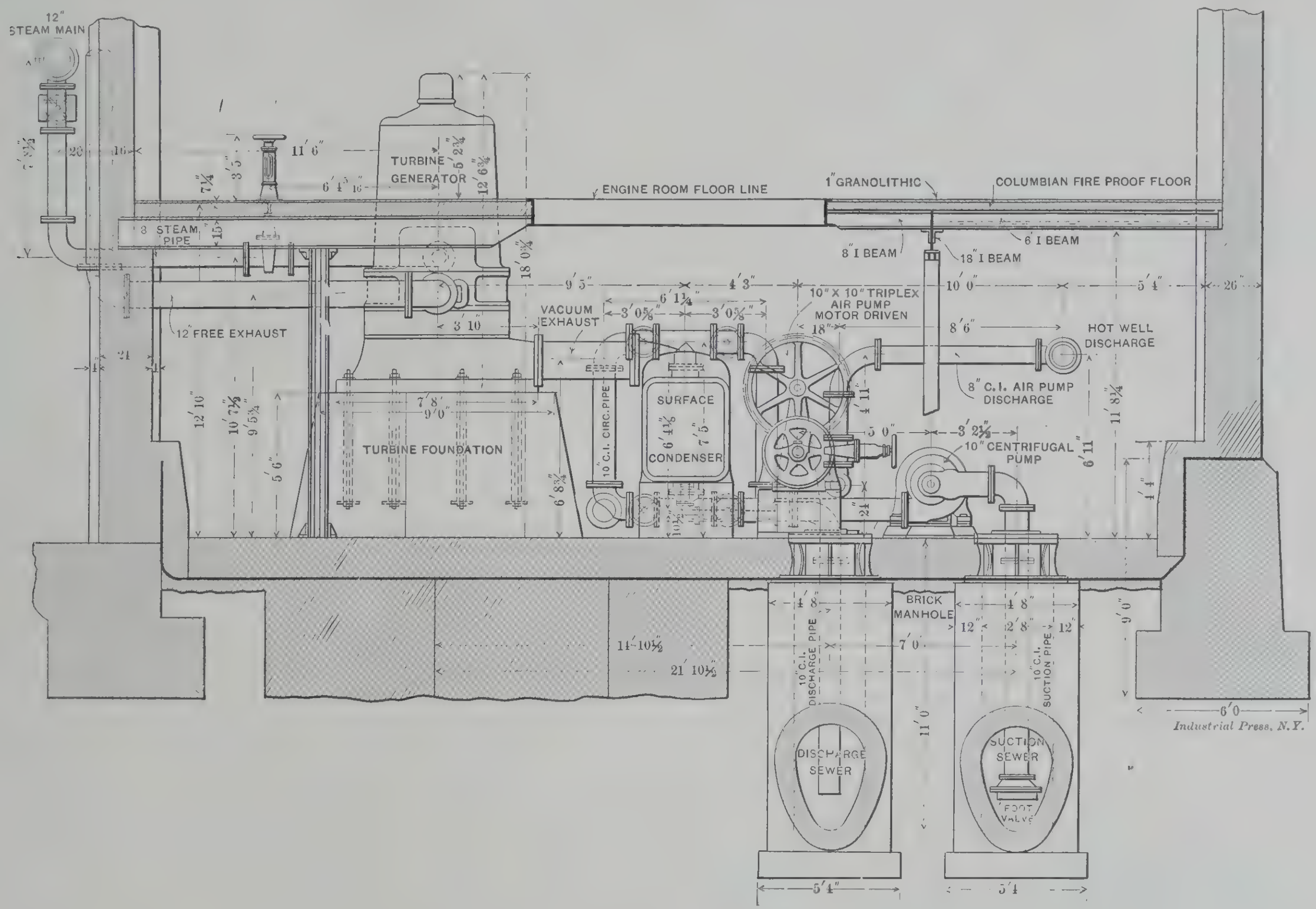


Fig. 5. Elevation of Steam Turbine Installation at Newport, R. I.

turbine proper, the generator only being above it. These generators are 500 kilowatt, 2,500-volt machines, built by the General Electric Company and run at the turbine speed, which is 1,800 turns per minute. The turbines are 7 feet 8 inches diameter at the base and 12 feet 6¾ inches high from the bottom of the bedplate to the top of the governor cap. A heavy foundation of brick is provided for each unit, the dimensions being 9 feet square at the top, 11 feet at the bottom and 5½ feet high. Beneath this is an 18-inch bed of concrete.

* * *

A NEW MOTOR DRIVEN LATHE

WITH VARIABLE SPEED MECHANISM.

Since the introduction of electric power for driving lathes and other machine tools, many designs have been made for adapting the motor to the tool. The first method employed was to run a countershaft from the motor and then drive the tool from this countershaft in the usual manner. Then builders began making provision for the motor as a part of the tool; yet even at the present date, in many of the electrically operated tools the motor has a decidedly "stuck on" appearance. The Flather Co., Inc., Nashua, N. H., have just brought out an electrically operated lathe which provides for incorporating the motor as a part of the tool in a very novel manner, as well as doing away with belts, chains or similar devices.

The photograph, Fig. 1, illustrates their 14-inch engine lathe, which has been equipped in this manner, and Fig. 2 shows a detail of the motor connections and driving mechanism. The motor is placed in a box leg, and while in the present case it is shown on the right hand side of the leg, it can be placed at the left equally as well. When placed as shown in the photograph a plate is cast in the bed to protect the motor from all chips and dirt. The body of the motor is held firmly in place by means of lugs fastened to it and in turn screwed to the leg, while the inner end fits into a hole bored in the cross ties cast in the leg.

On the end of the armature shaft is a rawhide pinion, *A*, meshing with metal bevel gears *B-B*, turning them in opposite directions. These gears are keyed to the frictions, *C-C*, and are connected or disconnected by the lever *D*. This lever, which starts, stops and reverses the lathe, runs the full length of the bed and is convenient at all times to the operator. On the upper end of shaft *E* are keyed five metal flanged rawhide gears of different diameters, which mesh with five corresponding gears running loosely on shaft *H*. These gears are connected to shaft *H*, one only at a time, by means of a key, *I*, which slides in a keyway cut in the shaft. When the key *I* is moved from gear to gear by means of lever, *J*, it is depressed flush with the shaft by the collars placed between the gears *G-G*. By this means the key must be entirely out of one gear before the springs placed under the key can force it into the keyway in another gear; hence there is absolutely no way by which more than one gear at a time can be connected to the shaft *H*. On the upper end of shaft *H* is a bevel gear *L* meshing with a similar gear on the lathe spindle where the cone is usually placed. Back gears are operated in the usual manner. The lever *J* is very convenient for the operator and can be moved while the lathe is running, giving a quick change of feed instantly, with practically no shock or jar. The motor can be removed for inspection without disturbing any other part.

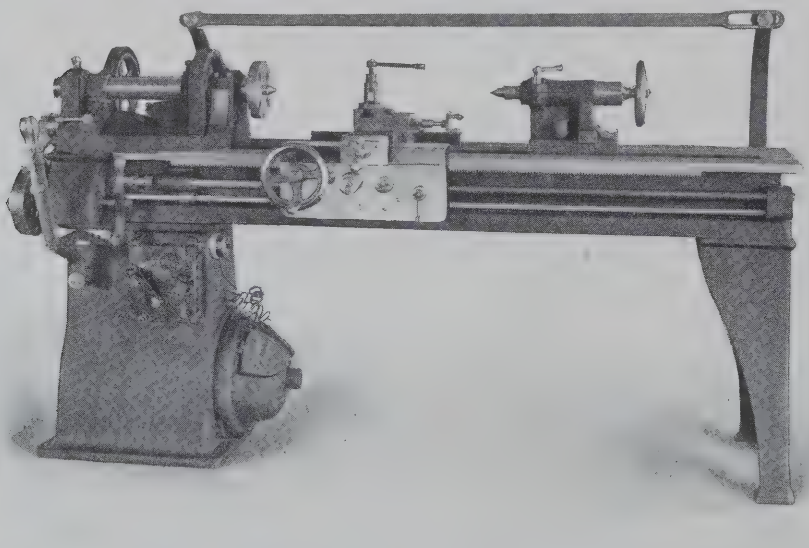


Fig. 1. Flather Lathe with New Design of Motor Drive.

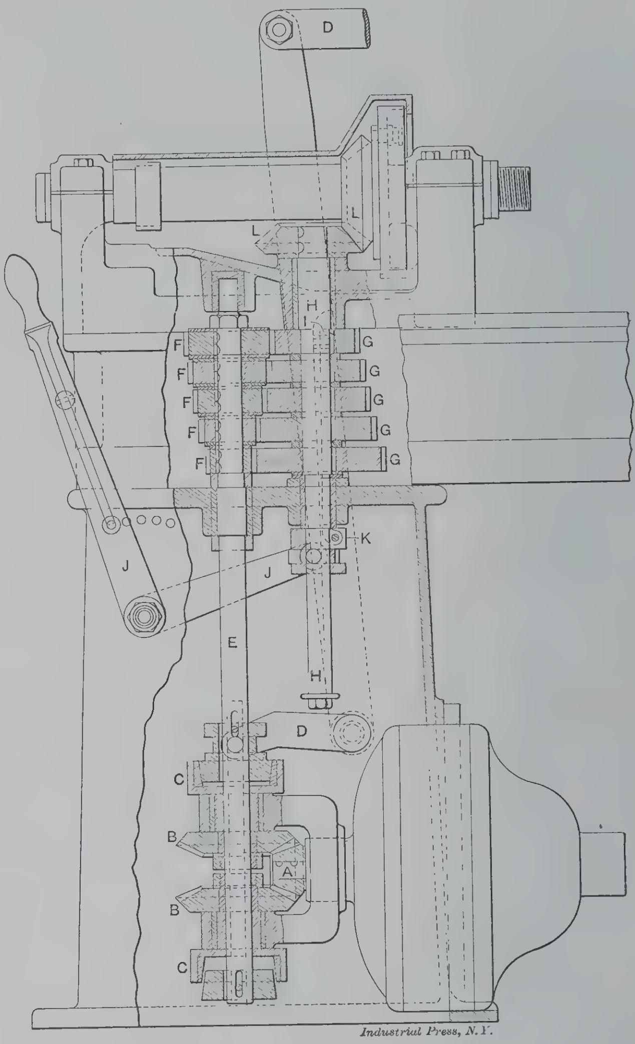


Fig. 2. Details of Connections between Motor and Lathe Spindle.

The lathe has been so designed that about any make, speed, or style of motor, either direct or alternating current, can be used, thus meeting the needs of each customer. The bevel gears have planed teeth, which reduces the noise to a minimum, while placing the motor as low as possible prevents any swaying or vibration.

* * *

Some time ago it was decided by a certain magistrate in Sheffield, Eng., that some utensils made of a malleable iron to which 25 per cent. of boiler punchings had been added, might be regarded as steel instead of iron. An analysis of the mixture showed the composition to be substantially the same as that of steel. While it could not be denied that the mixture was different from steel, and in reality malleable iron, yet no chemical or microscopic test showed wherein it differed. Prof. J. O. Arnold, of the University College, undertook to find out what a logical definition of steel would be. He was finally obliged to resort to a definition based upon the process used in making the material rather than to a definition of the characteristics that should be possessed by the material. The question "What is steel?" therefore, still requires a direct answer. The qualities of certain grades of steel border so closely upon those of certain grades of iron that it seems impossible to know where to draw the line other than to give a description of the means of producing the metal.

STEEL AND ITS TREATMENT.—7.

ANSWERS TO INQUIRIES.

E. R. MARKHAM.

The writer is pleased to note a growing interest in the subject of hardening steel, and should this be due in any measure to the series of articles on this subject published in MACHINERY he will feel amply repaid for the part he has taken. As so many letters have been received from readers who were desirous of learning some point not brought out in the articles, it has seemed wise to answer them in the form of an article, rather than to answer the letters personally. In the latter case only the party receiving the letter would be benefited, while if published in the form of an open letter, or article, some who have not made inquiries as to the cause of troubles they were experiencing will be enlightened also.

In the first place, to become a successful hardener one must be somewhat familiar with the nature of steel. This knowledge may be gained by a study of books written on this subject, but while there are many works devoted to this subject there are few that would be of any special benefit to the average mechanic. The writer would, however, recommend Metcalf's work entitled "Steel, A Manual For Steel Users," in which the subject is presented in a clear, concise manner, and can readily be understood by any man of ordinary intelligence. The composition and nature of steel is treated of in a way that will benefit any careful student of the book.

Another work which the writer found of much value when studying the subject was written by an English authority—W. Matthieu Williams.

Letter No. 1 informs me that the writer had a number of long tools to harden, and becoming greatly interested in the heating of steel in red hot lead, he decided that this would furnish an ideal method of heating the tools. Results were anything but satisfactory, the steel was brittle, the tools did not stand up well, one part was apparently not as strong as another, and in fact he didn't believe (upon trial) that red hot lead furnished as satisfactory a means of heating steel as one might imply from reading articles on the subject. When the hardened steel was broken the grain was coarse, and withal he "was very much dissatisfied with results obtained."

Now, in answer to the foregoing, would say, that probably no one method so universally used in heating steel is the cause of as much annoyance as red hot lead—because *certain points* are not observed. While an impure lead may lead to unsatisfactory results, so far as the surface of steel is concerned—and for this reason *chemically pure* lead should always be used—yet an open grain is the result of high heats. In other words, the amount of heat a piece of steel receives rather than the method of applying it, affects the *grain*. Then again lead is not as hot on the surface as lower down in the crucible, and consequently when long pieces are heated the portion of the steel near the bottom of the crucible is apt to be much hotter than that nearer the top, unless the lead is stirred occasionally to equalize the heat. This undoubtedly accounts for the difference in the amount of brittleness in various parts of the piece.

Unfortunately very little attention is paid in most shops to the location of any apparatus used in heating or making steel. If after installing the machinery there is a place left in the shop that apparently can never be used for any other purpose, the furnace used for heating steel is placed there. Many times the location is directly in front of a window or where some strong light will shine in it, or in the workman's eyes; and, as a consequence, the heats cannot be observed as they should be, and steel is overheated. To obtain satisfactory results the furnace must be so located that the heats can be readily observed by the operator, or the articles will be overheated. Lead furnishes a very satisfactory method of heating small pieces of work, if care is observed in selecting the lead and in the amount of heat given.

Letter No. 2 contains the following complaint: "When hardening milling machine cutters, of the form shown in enclosed sketch (Fig. 1), the steel cracks at the root of the tooth. A cutter with 20 teeth will sometimes come out of the bath with only 9 or 10 teeth that are not cracked, and in many cases the teeth will have been broken off entirely, and will be found in the bottom of the tank. We are using what is recommended to us as the best steel for the purpose. Can you recommend a good steel for the above-mentioned tools, one that will not crack when it is hardened?"

I am very loath to say anything about a make of steel for any given purpose; because, in the first place, it is evident that the fault is not altogether, if at all, in the steel used, but rather in the manner in which it is used. Almost any of the *leading* brands of steel on the market give good results if properly treated, and *none* of them act satisfactorily unless properly treated. And in many cases the steels that give best results if handled properly, require more careful treatment than some steels that will not do as much work when hardened. It must be borne in mind that steel is given a higher percentage of carbon than formerly so that tools may run at higher rates of speed, and cut harder stock than formerly. The higher the percentage of carbon the more care it must receive when being heated.

When steel is heated it is expanded to a considerable degree, and when plunged in the cooling bath the process of contraction takes place. Now, as the teeth are slender, they chill, and consequently are hardened much more quickly than the more solid portion between the bottoms of the teeth and the hole. Being hardened they are unyielding and cannot conform to the contraction of the balance of the piece, which continues for some time; and the result is that the heavier portion is reduced in size and shape, and the teeth, being inflexible, cannot conform to the change. Consequently the steel is torn apart at the point where the two portions—teeth and body—join.

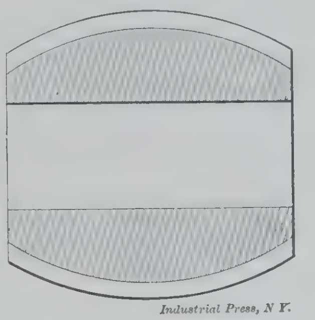

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Fig. 1. Section through the Milling Cutter.

If the process of annealing is resorted to after the mill is blocked out to shape—or somewhere near to shape—the tendency to crack is reduced; this was explained in our article on annealing.

Uneven heats are many times a source of trouble when steel is hardened, as then the steel is contracted more unevenly than would otherwise be the case. Some hardeners get excellent results by dipping the cutter in a bath of water or brine having one or two inches of oil on its surface; the cutter is passed down through the oil into the water, which should be warmed somewhat.

In the article in the January number an excellent method is described, namely, dipping in water or brine until the teeth are hardened, then removing and plunging into oil and leaving until cold.

When it has not been possible, or has not seemed advisable for some reason, to anneal the blank after it was blocked out somewhere near to shape, it may be heated, when it is ready for hardening, to a red and allowed to cool off, and then reheated and hardened. This has the effect in a measure of reducing the tendency to crack from internal strains. Never use *cold* baths for hardening articles of the description mentioned; warm baths give fully as good results and are not nearly so apt to cause the steel to crack. This tendency to crack will be reduced if the angular milling cutter used in cutting the teeth is slightly rounded on the points of its teeth; sharp corners are always an invitation for steel to crack when hardened.

The hardener should bear in mind the fact that the lower the heat given a piece of steel when hardening—provided it is hot enough to produce the desired result—the less brittle the steel will be, and the less liable to break from the effects of contraction. And again if steel is brittle it is necessary to reduce the brittleness by drawing the temper to a degree that makes it softer than it should be. Knowing this the hardener will endeavor *never* to overheat or heat unevenly a piece of steel, especially when it is of a form that betokens trouble.

Letter No. 3 reads: "I am called upon to harden a great many springs, which are made mostly of sheet steel, punched and bent to shape. Formerly the springs were made of a good quality of tool sheet steel, and we had very satisfactory results when they were hardened in lard oil, and the temper drawn by 'flashing' the oil. This was accomplished by placing the springs in a long-handled pan, moving the pan back and forth over a fire until the oil on the springs caught fire and burned. But our people were convinced that a cheaper steel would answer the purpose as well, and so bought some made especially for springs. This apparently hardens all right, but if the oil is 'flashed' off of it the springs are too soft." The people who sold the steel state that others are having excellent results using this steel for springs similar to the ones we are making. Is the trouble with me or with the steel?"

In answer to this would say that, not having tested the steel I do not know as to its adaptability for the job in hand. Many times steel is sold to the consumer by a local dealer who knows no more about the metal than a sailor does about preaching. It is advisable when ordering steel for such purposes as the one mentioned to consult the makers, telling them exactly what is expected of the article. Any of the reliable steel concerns, when they know what is wanted of a steel, will furnish the desired quality, together with necessary instructions as to treatment. However, as the steel used, apparently hardened all right it was, in all probability, not high enough in carbon to allow of drawing it as low as the tool sheet steel. Now in order to find the proper temperature it would be necessary to experiment somewhat. A few springs could be placed in a kettle of oil provided with a thermometer and whose contents were heated to 550 degrees, and the springs could be tested. If this temperature left them too hard, one could heat somewhat hotter, and this experiment could be continued until they show the proper amount of elasticity. An excellent spring can be made from steel not high enough in carbon to stand up when oil or tallow is flashed off of it, if it is heated to the proper degree when tempering.

Letter No. 4 conveys the information that the writer has never done very much hardening, but has read every book and mechanical journal containing information pertaining to hardening steel, and consequently considers himself well qualified to take charge of such work. In fact he has succeeded in securing a position as foreman of a hardening plant, but certain things have arisen that require expert judgment on matters that are not considered in any of the books or articles he has read. Now it is a fact—unfortunately—that manufacturers consider it necessary to make certain articles of a form, and from stock that must be treated somewhat differently from the ordinary methods. Right here the practical, experienced hardener finds the information he has derived from the study of books and technical papers valuable; for, while the work in hand may be different from anything he has experienced or read about, if he understands the nature and peculiarities of steel, he will be able to devise a way of doing the work. Experience is a very valuable and necessary qualification for a man if he is to become a successful hardener of steel, but that alone will not qualify him to successfully meet new propositions.

The study of steel, and of methods of manipulating it is intensely interesting and very necessary but taken alone it does not qualify one to become a hardener of steel, much less to take charge of a department doing this class of work. For matters are constantly coming up that require a certain "judgment" that can only be acquired by experience. In no branch of shop work is a man in charge required to rely more on the fruits of his past experience than in the hardening department. If in addition to this experience he has a thorough knowledge of the metal he is working, he is an invaluable man.

In the past the subject of steel and its treatment has been given very little consideration, but now that manufacturers are paying more attention to it the temptation is very strong for some men who have given the subject a little study and who in addition to this are blessed—or cursed—with too much self-confidence, to represent themselves as thoroughly competent to assume responsibilities. This can but end disastrously to themselves and to the concern employing them, and it must also reflect on the cause which the writer and others are trying to elevate, namely, the "Study of Steel and Its Treatment." The only advice we can give the writer of letter No. 4 is to give up his position before it is taken from him, and to get a job in a hardening plant doing a variety of work, becoming familiar with the work in hand. Then the value of his study will be apparent. But let him keep right ahead with his studies; he will never be too old to learn, or if he does get too old to learn, he can take it for granted he is too old to continue in this line of business.

Letter No. 5 informs me that a party is having trouble hardening cylindrical pieces; soft spots are constantly bothering him. It may be a little consolation for him to know that he is not the only hardener who has been troubled with soft spots when hardening work of a cylindrical form, especially such pieces as have surfaces perfectly plain; that is, without teeth or other irregularities. But as the knowledge that other people have similar troubles is of little practical value, we will consider a method—or rather some methods—of doing away with this trouble.

A very common error in the making of articles other than cutting tools is to use steel just large enough to clean out when machined. As a consequence the decarbonized portion referred to in a previous article is not removed entirely, and the result is soft or spotty surfaces. Then again, if the piece is heated in a manner that exposes it to the action of the air, or to the fire, the surface is liable to become oxidized, and the scale of oxide raises in the form of blisters, holding the contents of the bath away from the steel. Thus it cannot come in contact with the steel, and therefore it cannot absorb the heat at this point rapidly enough to cause the steel to harden. This tendency to oxidation may be overcome by placing the article in a tube or some receptacle which will prevent its contact with the air or fire. Better results will follow if the articles are packed in a box or tube with some carbonizing material, the receptacle being sealed with fire clay to keep the air from entering and the gases from escaping. When the steel has reached a uniform low red heat remove the pieces and dip in brine. If the material for making the article is tool steel, the carbonizing element used may be charred leather. If, however, it is high carbon steel, better results will follow if a mixture of hoofs and horns is used in place of charred leather especially if the steel is to be exposed to the action of the carbonaceous material for any length of time after it is red hot. An excellent plan is to place a quantity of chemically pure cyanide of potassium in an iron dish or crucible, heat it to a low red, suspend the article in it until it has reached a uniform low red heat, when it may be removed and immersed in a bath of brine or a solution of cyanide of potassium and water.

My object in answering these questions through the columns of MACHINERY is that I think, with the exception of one, that they are representative of troubles that may have been experienced by quite a number of readers.

* * *

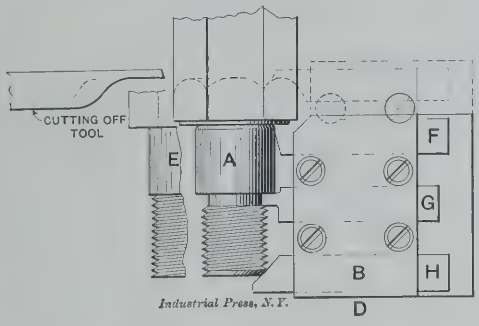
Molybdenum is a metal which, until recently, has been but little known outside of the laboratory, and its name even now is strange to the general public. Of late years, however, it has been much inquired for. It has been found superior to nickel for hardening and toughening steel. It is even better than tungsten for that purpose. Nickel makes steel tough; tungsten makes it tough and hard; but tungsten steel is disposed to crack under impact. Molybdenum makes the steel both tough and hard and does not make it brittle. It has the additional quality of keeping the steel cool. It is, therefore, valuable in the manufacture of quick-firing guns. Molybdenum is one of the most refractory of metals. It cannot be melted in any furnace, nor even under the blowpipe. Nothing but the electric current will reduce it to a liquid state. A current of about 50 volts and 900 to 950 amperes will melt it. The ore resembles lead, and is mostly found in laminæ and thin wedge-shaped masses in quartz veins. It is generally composed of about 60 per cent. of pure molybdenum and 40 per cent. of sulphur. The greater part of the ore supply has hitherto come from Sweden; but small quantities have been obtained from Maine and Arizona. Recently it was discovered in the county of Hastings, Ontario. At the present time molybdenum ore, carrying 60 per cent. of the metal, is worth about 400 dollars per ton, and the pure molybdenum about 2 dollars a pound.—*Iron and Steel Trades Journal.*

LETTERS UPON PRACTICAL SUBJECTS.

CUTTING OFF BOLTS AND CHAMFERING THE HEADS.

Editor MACHINERY:

I have had several occasions to use the style of forming tool described by Mr. Hayes under "Screw Machine Tools for Making Bolts" in the January issue, but have found it impossible to get a finished head on bolts or studs by chamfering with the side of the cutting-off tool, for the reason that when the tool begins to chamfer, it puts a side strain on the bolt and causes it to break off when the center of the stock is reduced to about ⅛-inch diameter. This leaves a rough spot and a burr extending from the center to the edge.



Bolt Forming Tools.

I have shown in dotted lines on the cut clipped from the letter by Mr. Hayes, the chamfering tool placed at the back and the cutting-off tool cut back, as also shown by dotted lines, to relieve the side strain and allow the bolt to remain until it drops off by its own weight. F. C. ARRY.

Chicago, Ill.

FAVORS A NEW SYSTEM OF MEASUREMENT.

Editor MACHINERY:

I have read with great interest the arguments pro and con the metric system and it seems to me that each party in the argument is too firmly fixed in its opinion to yield to the other side. There is, however, a system which might conciliate both sides, and it is one that has already received some attention. I mean the duodecimal system which, to my mind, is the only natural and hence the rational system of numeration.

Some say that because we have ten fingers it is quite logical that the numeration should go by ten, since at first men computed upon their fingers as upon an abacus given by Nature. Well, I claim that we possess the duodecimal system as well as the decimal, if not better, as will be seen by referring to Fig. 1. It shows the left hand in which one can count up to 12 upon the finger joints, using the thumb as an index or pointer, and this requires the use of but one hand, leaving the other free for figuring. To count ten upon the fingers requires the use of both hands. A more striking proof that this is the natural system is found in the circle. Is it not naturally and geometrically divided into 12 parts? On a circle (Fig. 2) lay off two diameters making right angles with each other and from each intersection with the circle strike arcs, equal to the radius, cutting the circumference two by two and you will obtain exactly 12 equal divisions. Why then divide the circle into four "quadrants" of 100 "grades" each, as is now done by the topographical and hydrographical surveys of the French Government? Four hundred has never divided the circle logically while 360, being a multiple of the hexagon and duodecagon, is the natural division.

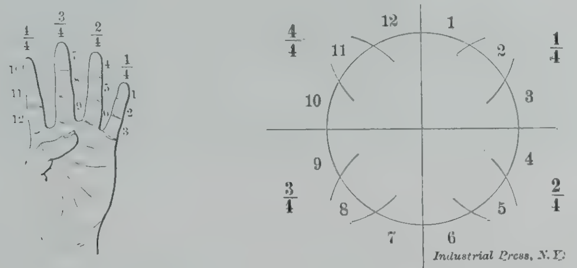


Fig. 1. Fig. 2.

Illustrating the Natural System of Numeration.

Coming now to the practical side of the question, I have something to propose in lieu of the meter and the foot, and a "natural" measure, too, which is as universal and "non-national" as is the second for computing time all over the world. The proposed standard measure should be the length of the pendulum that beats seconds at the equator line and at the sea level. Such a length is subject to no contestation whatever. Whether measured in inches, in millimeters or otherwise it is still the same. Some will raise the objection that all the existing machinery would have to be changed, as also the measuring instruments, but practically it will cause no greater change than the one necessitated by the adoption of the metric measures. The duodecimal system and a new standard, natural and logical, is, I think, the best solution to give to a problem so difficult to solve only because of nationalities, for, besides having the advantages of the two others it possesses none of their disadvantages.

EDW. C. CHODZKO.

Haiphong, Tonkin, China.

SPIRAL GEARS AGAIN.

Editor MACHINERY:

The subject of spiral gearing seems to be a very vague one to some people, and if anything is written in this article that will be of any help or use to anyone, or supply some missing link, so that the subject may appear more clearly, then some good will have been done. The particular cause of this being written is the desire of a certain party to make a pair of gears such that, the axes being at right angles, the pitch diameters, and consequently the outside diameters, should be equal, but the ratio should be 1 to 2. For the purpose of illustration it does not make any difference what number of teeth or pitch the gears were actually made, as the rule will apply in one case as well as another. We will take a gear (preferably the driven) of 40 teeth and a pinion (or driver) of 20 teeth.

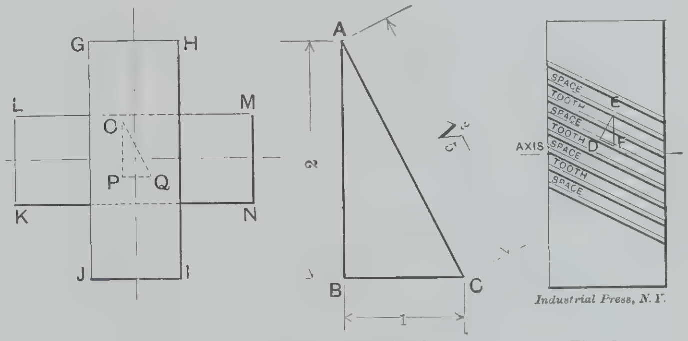


Fig. 1. Fig. 2. Fig. 3.

Spiral Gears.

Referring to Fig. 1, let *G H I J* represent a gear blank which we will place over another gear blank *K L M N* of equal size. Then it must be evident that if we are to cut twice as many teeth in the one as we do in the other the circular pitch, or the distance from one tooth center to the next, measured on the pitch circumference at right angles to axis, will be twice as great on the first as on the second.

Lay out a right angle triangle such that the line *B C*, Fig. 2, will be 20 units long, or say equal to 1 to represent the pinion, and the line *A B*, 40 units long, or equal to 2 to represent the gear. Then if we consider the line *A B* to be the axis of the gear, the line *A C* will be the direction of the line of the teeth, and angle *B A C* will be the angle which the gear must be moved so that the cutter may properly form the teeth.

Likewise if we consider *B C* the axis of the pinion then angle *A C B* will be the angle of the teeth. Or stating the same thing in a different form, the acute angle adjacent to the line representing the pinion in a right angle triangle is the angle of the teeth of the pinion. And the corollary to this, the acute angle adjacent the line of the gear is the angle of the teeth of the gear.

To prove that this is correct, we will solve our triangle as constructed and find angle $B\ A\ C$ equal to 26 degrees 34 minutes, and angle $A\ C\ B$ equal to 63 degrees 26 minutes. Then if our gear is to have 40 teeth and cut with an 8 diametral pitch cutter the normal circular pitch ($D\ E$, Fig. 3) is .39269 which corresponds to the circular pitch of spur gears. But the circular pitch of a spiral gear is measured on the pitch circle but at right angles to the axis or on line $E\ F$, Fig. 3, and not on the line $D\,E$. Angle $D\,E\,F$ on our gear is 26 degrees 34 minutes, and side $D\ E$ is equal to .39269, therefore $E\ F$ is equal to .39269 times the secant of angle 26 degrees 34 minutes, or .39269 times 1.11803 is equal to .43903, which gives us the distance of the spiral circular pitch. This, times the number of teeth, which is 40, gives us 17.5616 inch as the pitch circumference.

Taking the pinion in the same manner, the angle of the teeth equals 63 degrees 26 minutes, also angle $D\ E\ F$ is the same. Therefore, $D\ E$, which is the .39269 as before, times the secant of 63 degrees 26 minutes will give the spiral circular pitch; or $.39269 \times 2.23607 = .87808$. This, times the number of teeth in the pinion (20) equals 17.5616. This result shows that the pitch circumferences of the pinion and the gear are the same, consequently the pitch diameters are equal.

The above may be reduced to a formula and the operations shortened considerably.

Let $D\ P$ equal diametral pitch of cutter used.
N equal number of teeth wanted.
$P\ C$ equal pitch circumference.
$P\ D$ equal pitch diameter.

$$\text{Then } \frac{\pi}{D\,P} \times \text{sec. of angle} \times N = P\,C \quad (1)$$

$$\frac{P\,C}{\pi} = P\,D \text{ or } P\,C = \pi \times P\,D$$

Substitute this in (1) and cancel π from both sides of equation.

$$\frac{1}{D\,P} \times \text{sec. of angle} \times N = P\,D$$

$$P\,D = \frac{\text{sec. of angle}}{D\,P} \times N$$

Thus, the secant of the angle of the teeth divided by the diametral pitch of the cutter and that result multiplied by the number of teeth in the spiral gear will be the pitch diameter of the gear. Therefore in our pinion of 20 teeth if we take the secant of 63 degrees 34 minutes and follow our rule we shall have 2.23607 divided by $8 = .27951$. This, times the number of teeth $(20) = 5.5902$ as the pitch diameter.

This method considerably shortens the operations and renders the liability of an error much less. This rule will apply not only to gears of this particular angle but to every angle that it is possible to cut on a gear cutter or milling machine and with diametral pitch cutters, and also puts the matter in such a form that anyone able to understand the first principle of trigonometry, can easily determine the pitch diameter of a spiral gear and not have a large sheet full of figures with which to contend. E. M. Willson.

Madison, Wis.

MAKING STEEL CYLINDERS.

Editor Machinery:

In a shop which I recently visited, my attention was attracted to some large cylinders of tool steel which were hardened and ground, and an investigation as to the way in which this was accomplished showed some points of shop practice that will, without doubt, be of interest to Machinery readers.

Some of these cylinders, which were from 10 to 12 inches long and 5 to 14 inches in diameter, were made in one piece, as shown at A, Fig. 1, while others were made in halves as at B. It was a simple matter to forge the halves but forging the whole cylinders was considerable of a job since they had to be made without a weld. This was accomplished by using a block of steel of the length of the cylinder and of sufficient cross section to form the shell. The block was drilled with a series of longitudinal holes, as shown in Fig. 2, which is an end view of the block. This was then wedged open and forged to the proper shape. In hardening, it was the half cylinders that threatened trouble as it would be practically impossible to harden them without warping unless some means was provided to prevent it. The means employed in this case consisted of two clamps which were placed over the open side and held the shells securely in shape while they were passing through both the furnace and the hardening bath. These clamps are shown in position in Fig. 3. After hardening, the shells were ground internally on the rig shown in Fig. 4, in which a half shell is shown, mounted for grinding.

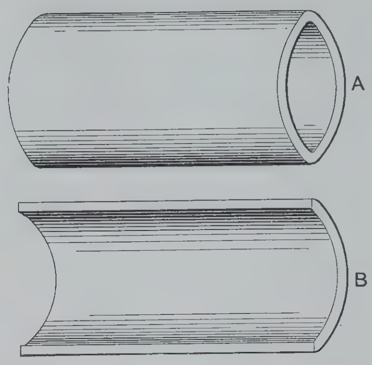
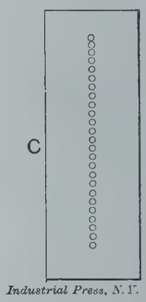
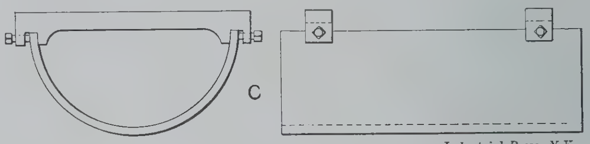


Fig. 1. Steel Cylinders.



Industrial Press, N.Y.

Fig. 2. Block for Forging Cylinders.



Industrial Press, N.Y.

Fig. 3. Clamps for Holding Half Cylinders when Hardening.

This is essentially a boring machine with a revolving wheel substituted for the usual boring tool. One end of the bar is held in a chuck, which is screwed to the spindle of the machine, and arranged so that it may be adjusted radially by means of the hand nut B. The other end of the bar is carried on a similar but simpler chuck on the dead center of the machine. The wheel and belt pulley are mounted upon a sleeve which runs upon the bar and is driven at the proper grinding speed by the belt A. The bar itself is rotated at a slower speed with the wheel set sufficiently off center to cause it to grind to the required diameter. When the internal grinding is completed, the shells are ground externally, on an arbor, in the usual manner. H. P. Fairfield.

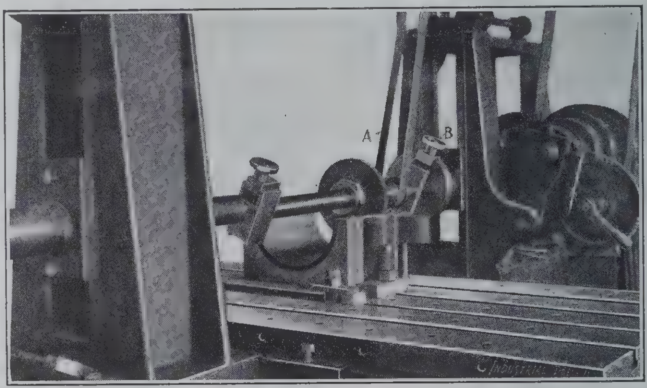


Fig. 4. Arrangement for Grinding the Cylinders.

Worcester, Mass.

A SPECIAL PUNCH AND DIE JOB.

Editor Machinery:

Not long ago the writer was employed in a shop engaged in the manufacture of a cheap line of sheet metal goods and one of the jobs there encountered seems of sufficient interest to illustrate for the readers of Machinery. This was the production of the bodies of the so-called chain purses. These consisted of a series of rings held together by a four-pronged setting. A section of these purse bodies is shown in Fig. 1; the two lower rows show the rings as they came in strips from the punch, while the two upper rows are shown fastened together by the settings. One of these settings as it comes from the press is shown in Fig. 2. Both rings and settings were formed upon the power press and we will first consider the tools used for making the settings or links that hold the rings together. Referring to Fig. 3, *D* shows the cutting die which was made from a piece of tool steel recessed into the block *C* and flush with its upper surface. Over this was fastened the stripping plate *B* containing the slot *A* for guiding the stock. Recessed very carefully into the body of the plate was the circular disk *Z*, which revolved around a central stud. Upon the edge of this disk were cut the pawl and stop-pin notches so as to index the dial eight times to a complete revolution. To the left of the dial was a slide *P*, which carried the indexing pawl *M*, and was provided with a return spring *S* and an adjustable stop *W*. The stop lever *Q*, which worked in a recess in the face of the plate, was actuated by the spring *R*, of sufficient strength to bring the dial into exact position in case the pawl should vary in its action. The eight holes, *X*, *X* were so located in the disk *Z* as to come exactly central with the die as they were brought around by the indexing mechanism. These holes were counterbored at *Y*, the counterbore being a trifle larger at the top than the diameter of the blank so that it could be easily forced to the bottom where it remained until indexed around under the drawing punch which operated at *H*. This punch drew it into the shape shown in Fig. 2 and carried it through the hole *H* out of the machine.

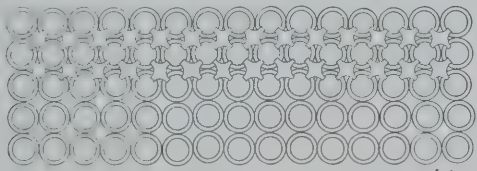


Fig. 1. Section of Chain Purse.

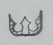

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Fig. 2. One of the Settings.

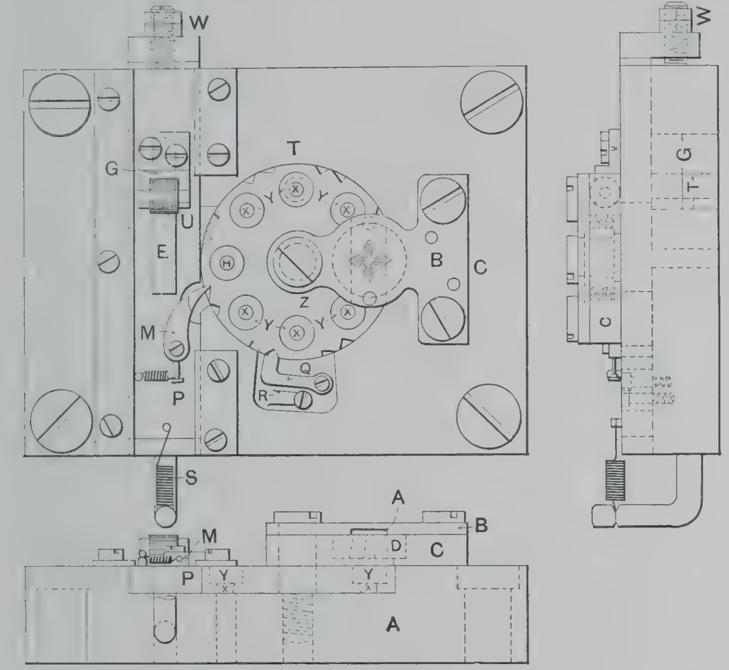


Fig. 3. Die for Making the Settings.

The punch, which is shown in Fig. 4, consisted of three parts—the blanking punch, *D*, which is shown in section in Fig. 5; the drawing punch, *F*, and the cam *G*. Through the center of the blanking punch was a small piece of wire, having a collar at its lower end against which bore a spiral spring. This spring pin was held into the shank of the punch by means of a headless set screw. The object of this spring pin was to push the blank firmly into the recess in the dial and also to prevent the blank from sticking to the punch as it would be apt to do if some such means of prevention were not provided. The drawing punch, *F*, was held in the holder, *E*, by means of a set screw, *K*, but the hole in the shank was considerably deeper than the end of the punch so that if the dial should not index properly, and the punch should strike against it, *F* would slide up into *E* instead of being broken. The cam, *G*, was set so that it would engage the cam roll, *U*, Fig. 3, and thereby index the dial. The hole at *T* was to provide an escapement for chips which, before it was put in, caused some trouble in the working of the dial.

The operation was as follows: The stock, which came in strips, was fed into the slot *A* by means of an ordinary roller feed. As the blanks were cut out they were forced by the spring pin, in the punch, into the bottom of the recess *Y*, where they remained until indexed to *H*, when they were drawn by the punch *F*, Fig. 4, and fell completed out of the machine. With each descent of the punch *X* the cam *G*, engaging with the roll *U*, caused the plate *P* to slide outward sufficiently for the pawl to index the dial one notch. After the cam had ascended, the plate was returned to its original position by the spring *S*.

The punch and die for forming the rings are shown in Figs. 6 and 7 and form a comparatively simple tool. The stock in strips was fed, by hand, into the die at *A* in the direction of the arrow and held firmly against the side *K* by means of the spring-gage *B*. After each cut the stock was moved forward until the edge came to the points *E, E*, which were very accurately filed on the set edges. The stock first encountered the punches *G, G*, which cut out the outside of the rings. Each side of the hole made by these punches was about .003 inch less than a quarter of a circle, so that about .006 inch of metal was left to tie the rings together. After this punching they came to the round punches *F, F*, which removed the metal from the center of the rings and left remaining the plate of rings shown in Fig. 2. The settings were then put in place by girls and "set" in a foot press, after which the piece was rolled a couple of times in the hand and the stock between the rings was easily broken, leaving a flexible body.

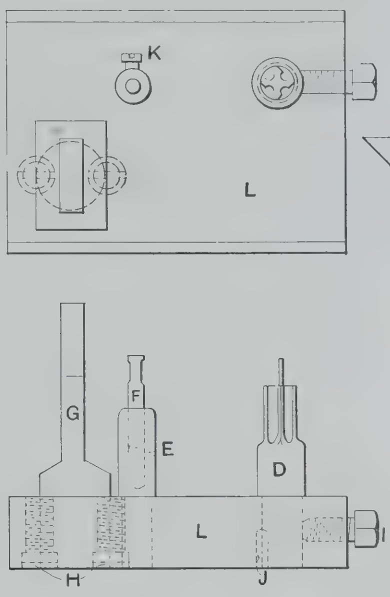


Fig. 4. Punch for the Settings.

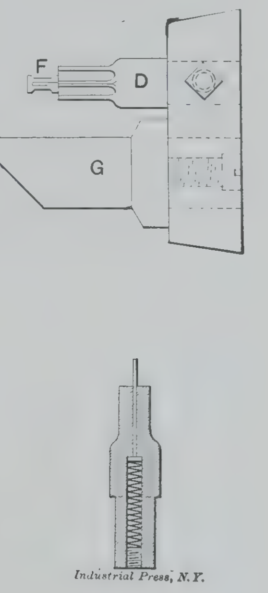
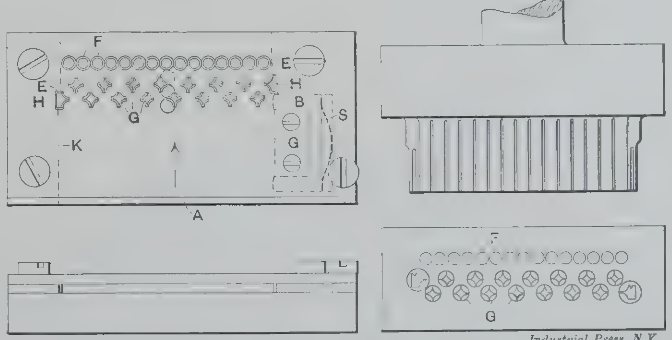

Industrial Press, N.Y.

Fig. 5. Section through the Blanking Punch.



Industrial Press, N.Y.

Figs. 6 and 7. Die and Punch for Making the Rings.

TEDDY.

CUTTING SPIRALS ON THE UNIVERSAL MILLING MACHINE.

Editor MACHINERY:

I have frequently been asked, by shop-men, for instructions for figuring the gearing required for cutting spirals on the universal milling machine, and having done considerable of this work in times past, I thought a letter upon the subject might be of assistance to some fellow workman. The makers of universal milling machines usually furnish tables with the machines, showing the proper change gears for a number of spirals. But many are not content to use the tables blindly; they wish to know the why and wherefore of the rules, so that should pitches be required which are not in the table they would know how to go about it to figure the change gears required. The principle is the same as finding the change gears for cutting screw threads in the lathe, but the lead of the milling machine is much coarser than is found on the lathe and is given as inches to one turn, instead of turns per inch. As the screw of the milling machine has usually four threads per inch, and as the spiral head takes 40 turns of the worm for a revolution, if equal gears are placed on the machine, the lead would accordingly be $\frac{1}{4}\times 40 = 10$ inches to one turn.

It is usually necessary to compound the change of gears for the milling machine. The spiral pitches given in the tables are usually in decimals, which is probably because the pitches are approximations to what the gears actually give. To keep the number of change gears within reasonable limits a comparatively small number of gears may, by compounding, be used for a large number of spirals. Suppose, for example: It is required to find the change gears for a spiral of 1.25 inches to one turn. Then the required spiral placed over the lead of the machine would give the ratio of gears required or $\frac{1.25}{10} = \frac{1}{8}$. This means that the required spiral is ⅛ of the lead of the machine and that the product of the number of teeth of the driving gears must be 8 times the product of those in the driven gears. Now in order to compound the gears resolve 8 into factors thus: $\frac{1}{8} = \frac{1}{2}\times\frac{1}{4} = \frac{24}{48}\times\frac{24}{96}$ and gears of 24 teeth used as the two driven gears and gears of 48 and 96 teeth as the two drivers would answer if among the set, but as 24 is the smallest gear in the set (usually) and a gear as large as 96 teeth would not be likely to be found in the set we must find the other factors of 8; then $\frac{1}{8} = \frac{1}{3}\times\frac{1}{2\frac{2}{3}} =$

$$\frac{24}{72}\times\frac{24}{64}\begin{array}{l}=\text{driven gears}\\ =\text{driving gears}\end{array}$$

would answer. The 72 T gear could be placed on the screw, 64 for the first gear on stud, 24 for the second gear on the stud and 24 on the worm shafts. It would make no difference if the gears were transposed provided the gears on screw and first gear on stud are the driving gears from the example, for if the 64 T gear was placed on the screw and 72 as the first gear on stud, the ratio would not be changed.

For another example: Required the gears for a lead of 2.22 inches to one turn.

$$\frac{2.22}{10} = \frac{1}{4.5}\text{ nearly} = \frac{1}{2}\times\frac{1}{2.25} = \frac{28}{56}\times\frac{32}{72}\begin{array}{l}=\text{driven gears}\\ =\text{driving gears}\end{array}$$

These gears do not give exactly 2.22 inches to one turn. To find a closer approximation, multiply the ratio by 10, as $10\times\frac{1}{4.5} = 2.222+$ ins. = actual lead, but 2.22 ins. is near enough for practical purposes. For another example: Required to find the gears for a lead of 60 inches to one turn.

$$\frac{60}{10} = \frac{6}{1} = \frac{2}{1}\times\frac{3}{1} = \frac{64}{32}\times\frac{72}{24}\begin{array}{l}=\text{driven gears}\\ =\text{driving gears}\end{array}$$

To find what spiral a given set of gears will produce multiply the ratio of gears by 10, or divide 10 times the product of the driven gears by the drivers; the result is the number of inches to one turn. Thus, to prove the gears in the last example: $10\times\frac{64}{32}\times\frac{72}{24} = 60$ inches to one turn.

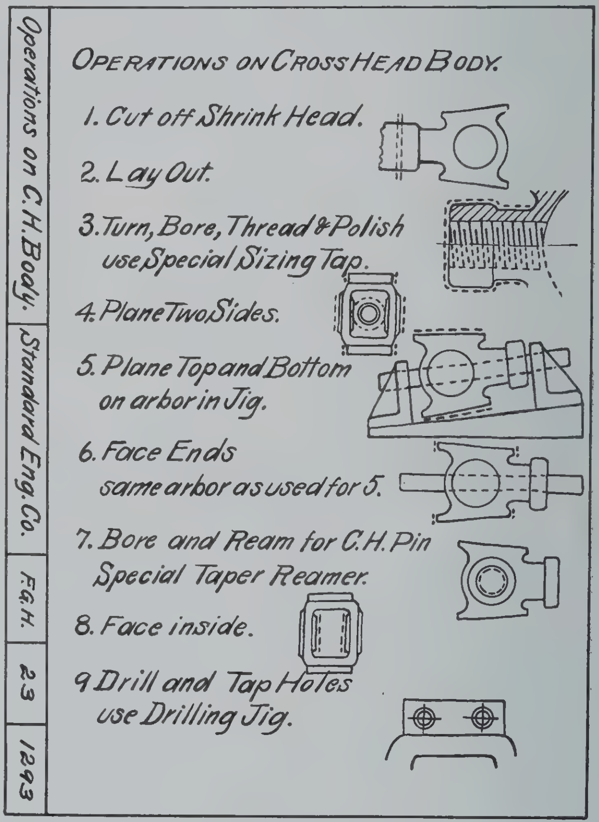
East Providence, R. I. JOHN T. GIDDINGS.

OPERATION SHEETS.

Editor MACHINERY:

I have read, in these columns, a great deal about various shop systems, but have seen very little about systematically outlining the different operations that are to be performed upon a piece of work. It seems to me that this is a very important subject, yet one that has failed to receive its due share of attention.

Before a piece of work is machined the foreman or machinist looks it over and decides upon the most direct and advantageous way in which it can be performed. The time is well spent that is taken for this preliminary planning, as a little forethought often saves a great deal of work. Having determined upon the best method of procedure, the piece is machined, but when the same thing comes up a few weeks later, unless the man is endowed with a good memory the same amount of preliminary thinking must be repeated. This trouble is more noticeable in the case of large work where the successive operations are done by different workmen, under orders from the foreman, so that it devolves upon him to keep run of the order of operations for all of the work under his charge. Now the question is: Having once determined the best way in which to do a piece of work, why not put it on record so that it will be at hand for future reference?



Operations on C.H. Body. | Standard Eng. Co. | F.G.H. | 23 | 1293

OPERATIONS ON CROSS HEAD BODY.

1. Cut off Shrink Head.
2. Lay Out.
3. Turn, Bore, Thread & Polish use Special Sizing Tap.
4. Plane Two Sides.
5. Plane Top and Bottom on arbor in Jig.
6. Face Ends same arbor as used for 5.
7. Bore and Ream for C.H. Pin Special Taper Reamer.
8. Face inside.
9 Drill and Tap Holes use Drilling Jig.

Specimen Operation Sheet.

This plan was followed in one shop with which the writer was connected and the results were such as to justify its more general use. This shop was engaged in building large steam engines, and when the drawings were ready for the shop the superintendent and the different foremen who were in charge of the work would "get together" and plan out the method of procedure. In this conference the head draftsman participated, and as the plans proceeded he made the rough sketches from which later one of the draftsmen would prepare the operation sheets. At this time it became apparent what new jigs and tools would be required, and these were taken under consideration by the chief draftsman. Thus the combined efforts of the different heads of the shop were for a short time concentrated upon the job in hand, and after that it was only necessary to follow the plans here decided upon. It frequently happens that the first time a job is put through the foreman or machinist will see an opportunity to improve upon the outlined method, and then the sheet is changed in accordance with the suggested improvement. Also any new tools or jigs that may be added are at once entered upon the production sheet.

These operation sheets were made on drawing paper, numbered as a regular drawing, and each foreman under whom the work would come was provided with a blue-print copy. The illustration is a copy of the operation sheet used for finishing the bodies of crossheads. The drawing and lettering was always free hand, with the possible exception of the circles, which can be drawn quicker with compasses. A dotted line indicates the surface that is finished by each progressive operation. Having seen the advantages that were derived from the use of this system, the writer fails to understand why its use should be limited to this particular shop.

George Frost.

[While we share Mr. Frost's enthusiasm in regard to the use of a systematic operation list, we do not think that its use is by any means limited to the shop in which he was employed, as we know of several shops in which similar systems are in operation. Mr. Frost has by no means exhausted this subject, and we should be pleased to receive contributions of sample operation sheets and additional suggestions from others employing similar methods for the systematic production of work.—Editor.]

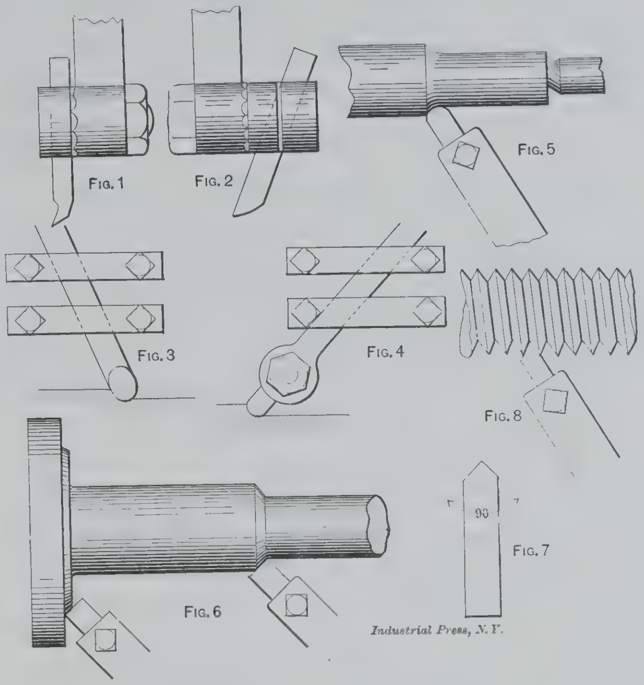
PATENT TOOL HOLDERS AND THEIR USE.

Editor Machinery:

Why is it that in many shops a number of patent holders for hardened steel tools will be found which are but little used or not used at all? There must be some reason for this and no doubt the utility of some patent tool holders is questionable; at least, not all are so adapted to all conditions as to make them of universal advantage. But when you observe side tools, cut-off tools, boring tools and off-set tools of all kinds and sizes, scattered broadcast about the tool-board while men wait for rough smiths to worry out awkward chunks of cast steel for them, and at the same time other men, who are a little more up-to-date and of an intellectual turn of mind, are plowing off the stock with twice the feed, a deeper cut and 30 per cent. more cutting speed than could be expected of those crude forged tools; then something must be wrong somewhere. Of course the whole difference cannot be due to the tool but the machinist who lives in the age of wrought iron when some of us have learned to cut soft steel is the same one who sticks to the tools in vogue "before the flood." To the writer the machine shop contains no greater mystery than the machinist who turns steel, however light the cut, at the old wrought-iron speeds and still holds his job. Those who have practiced a little on cutting speeds for soft steel find that for finishing with light cuts 200 feet per minute is just as easy on a nice sharp Mushet steel tool as 20 feet.

On the question of patent cut-off tools the writer has little to say, owing to the fact that in an experience of twenty years he has not seen a mechanic who could make or use one with any certainty of success. It is my opinion that some day some one will invent a cut-off tool that will be practical, but if such a tool exists at present it has not yet crossed my path.

Planer tool holders seem to be almost practical, and an improvement is suggested that will add to the efficiency of one of the best known forms of planer tool holders. It will be noticed that there is no rake to the cutter used in these tools, unless the shape of the steel is mutilated by top grinding which, if done, becomes worse and worse with each grinding of the tool. A holder should be so designed as to avoid all necessity of grinding the top of the tool and still maintain the same cutting angle until the tool is consumed in actual work. To accomplish this end the writer "doctors" such a tool holder as is shown in Fig. 1 in the manner illustrated in Fig. 2. The slot in the bolt is cut on an angle and a loose collar with a corresponding angular slot is inserted between the shank and the bolt so as to secure the steel tool on at just the proper angle for cutting. It will also be observed that instead of sticking the tool out in front of the holder it is hung on the back side so that it will spring away from the excessively heavy cuts instead of springing into the work. Another suggestion is to unlearn the old habit of setting the tool at the angle shown in Fig. 3. This we learned in our youth and it is difficult to forget, but the advent of the patent tool holder has made the change imperative and allows the tool to be set properly. The cutter should stand against the cut so that the strain due to cutting will come in the direction of the tool support and the rake of the tool is at all times in the direction in which the chip naturally travels. A tool set in this way (Fig. 4) will retain its shape with very little grinding and therefore the least waste of time and high-priced steel.



Patent Tool Holders and their Uses.

For lathe tool holders the common straight steel holder, as made by a number of manufacturers, is the most efficient. In the writer's experience off-set tool holders are practically unnecessary. As in the case with the planer tool the cutter is run ahead of the holder, as shown in Fig. 5, and this tool should be set as high at the point as good clearance will allow. The tool should be given some side clearance, as well as back, so as to allow a higher setting and consequently greater benefit from the rake which, as before stated, is not to be changed by grinding during the life of the tool. The great objection to top grinding is that it gets the point of the tool lower and weaker the more it is used.

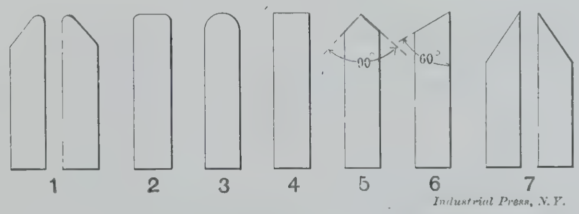


Fig. 9. Complete Set of Tools for Use with Patent Holders.

It is surprising what a variety of work can be done with the straight tool holder and the small number of inserted cutters that are required for all ordinary operations. An illustration of a few of these applications may be of interest to the lathesman. Take for example the casting shown in Fig. 6, it being desired to turn the hub and face the flange. Observe how with this tool holder the carriage seems always to be just where it is required. With the same setting of the roughing tool, run along the hub and down the flange and then with a single setting of the corner tool (Fig. 7) run a finishing chip over the same surfaces. With slight care in grinding, this tool is ever ready for use and may be used for a left-hand corner as readily as for a right-hand one.

Threading tools are made from a square piece of Mushet steel ground as in Fig. 8. Notice the angle at which the holder stands while the tool is at work. It is just right to enable the carriage and tool post to clear the faceplate, chuck or dog when threading close up, yet there is not too much of an angle for ordinary thread cutting.

Fig. 9 shows a complete set of the tools that, with a straight tool holder, will accomplish all ordinary lathe work.

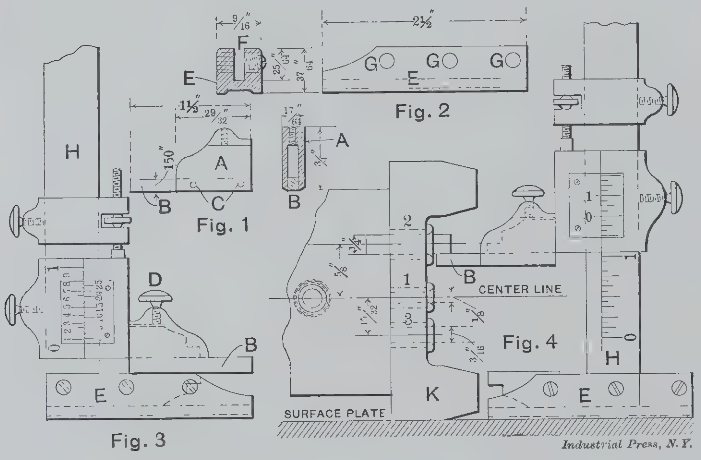
In grinding these tools always take them out of the holder, otherwise they will be too heavy and liable to heat when placed against the emery wheel. If the cutter alone is held in the hand it gives timely warning, by becoming too hot to hold comfortably, and is cooled off before it gets hot enough for the temper to be drawn. S. Byron Welcome.

Los Angeles, Cal.

AN ATTACHMENT FOR VERNIER AND SLIDE CALIPERS.

Editor Machinery:

While vernier and slide calipers are very handy shop tools their usefulness is much more limited than it should be for such expensive instruments. In order to increase the usefulness of these tools I have made the attachments shown in the accompanying sketches and have found them very practical and useful. In Fig. 1, *A* is made of machine steel, while the tongue *B* is of tool steel, hardened and ground and lapped to a thickness of .150 inch, the top and bottom being absolutely parallel. It is secured to *A* by the two rivets *C*, *C*. The thumb-screw *D* (Fig 3) is used to fasten the attachment to the sliding jaw of the vernier or slide caliper. Fig. 2 shows the base, which is of machine steel with the slot *F* milled for the reception of the fixed jaw of the caliper. The set screws, *G*, *G*, are put in at a slight angle so that the caliper will be held firmly and squarely in this base. In Fig. 3 these pieces are shown in the position for forming a height gage, for which purpose the attachment is most commonly used. As a test of the accuracy of its construction, when the attachment is placed in this position the tongue *B* should make a perfect joint with the fixed jaw of the caliper and the vernier should give a reading of exactly .150. When it is desirable that the tongue *B* should overhang, the base *E* is pushed back even with the stationary jaw as shown at in Fig. 4. In this position it is used for laying out and testing bushings in jigs, etc. The illustration shows the tool in use for this purpose, *K* being the jig to be tested. All measurements are from the center line upon which the bushing No. 1 is placed. Taking this as a starting point we find the caliper to read 1 inch. Bushing No. 2, which is undergoing the test, should be ⅝ inch from this center line. It has a ¼ inch hole, so through it we insert a plug of this diameter. Now adjust the tongue of the caliper to the bottom of this plug (as shown in the cut) and the vernier should read 1.625 minus one-half the diameter of the plug, or 1.500, and any variation from this will show the error of the jig. In this case the top surface of *B* was used and so no allowance had to be made for its thickness. In case the bottom surface is used, .150 must be deducted from the reading of the caliper.



Industrial Press, N.Y.

Workmen will agree with me that it is very easy to make a mistake in setting a bushing and that such a mistake is equally hard to detect unless some such means of measuring as this is at hand. It often happens that jigs and fixtures are put into use containing such errors and the trouble is not discovered until many dollars' worth of work has been finished and found worthless.

The sketch shows but one of the many uses to which this attachment may be applied.

The figures given on the detail are correct for making the attachment to be used upon the Brown & Sharpe vernier caliper but for other calipers they would, of course, have to be altered to suit. L. S. Brown.

Derby, Conn.

HOW TO READ "MACHINERY."

Editor Machinery:

"No use to study, wait till you need the knowledge, then go after it. Drop work at the whistle, you need recreation and plenty of rest to drive the cobwebs away. Got all you can do to hold your own job without thinking out Smith's problems, who holds a much better position than you do. Look at the boss; by no means a brilliant man; holds his position by pull. Don't waste time and money over Machinery, nothing in it but a few shop kinks you can never remember, and some technical articles of doubtful accuracy, etc., etc."

Such were the remarks recently made to me upon my inquiry if the speaker had seen certain articles in Machinery, and I have heard the same kind of thing so often before, and seen around me so many otherwise bright young fellows drifting along apparently unwilling to exert themselves in acquiring knowledge, but eager to sit with folded hands while someone else exerts himself in an effort to pound it into them, that I am led to believe that very few of the younger subscribers to such papers as Machinery know *how to read them*, or get their money's worth out of them. I feel quite a contempt for any draftsman or machinist who says he cannot afford a trade paper; why, no one can afford to be without one, or two, or more.

I am convinced, however, that very many subscribers to a paper glance through it in fifteen minutes each month, and lay it away, in the fond belief that in some mysterious manner it is going to benefit them. Just ask among the younger men in your establishment, who takes a trade paper, and having found one, begin to converse with him about any article found in the last issue, and note his replies. He hasn't read that number yet. Go back two or three issues. He has forgotten that article.

Like a good horse, or a full meal, a paper must be used to be found of value. How should Machinery be used?

Read every page. It is not "a fraud two-thirds full of 'ads.'" Despised "ads," an ever-changing cyclopædia of mechanic arts, yet so often ignored. First take a quick glance through the paper for any articles which discuss questions connected with your line of work. Master such articles; if necessary, correspond with the writer. Make a note of such articles as, though of no particular interest now, may be needed in the future. All machine design articles would come under this head for a draftsman, for instance, for, though widely separated from the present line of work, one can never tell what needs the future may bring forth; and so far from waiting till the need is felt, it should be remembered as a truism that no knowledge is needed till obtained. Therefore aim to be prepared. The well-informed man is not he who carries the most scattered information in his head, but he who knows where to find reliable information upon any subject that may present itself. An excellent thing for this purpose is a sample card index outfit sold for $1.25 by several of the makers of such goods. The outfit consists of one hundred ruled cards, a complete set of alphabet division cards, and a set of division cards for days and months, all contained in a very neat case to be kept on the desk or table. When several technical papers are read this case becomes an index of all that has passed under the owner's notice upon any given subject. It will be found a good plan to index thus such reference books as one may possess. If each time a subject is looked up it is entered in the index, it is easily found again, and it is surprising how soon such an index becomes valuable, and how little the task of thus completing it by degrees is felt. Glance through the column telling of new business firms starting up. It is well to know who are the people engaged in your business. Better have a place in which to keep their names and addresses, and watch for their "ads" later on. Read the "situation wanted" column to note how many men of your class are advertising for positions, and the "help wanted" column to compare with the former, thus getting an idea of the state of the market for the services of men in your class. As no one with potatoes to sell fails to watch the produce reports, why not keep posted on the market for time and brains if they are your marketable commodity? In the column of catalogues received, you are told the nature and something of the contents of many new catalogues, mention often being made of valuable tables and data contained therein. A request for such catalogues is rarely refused if made in a business-like manner in an inclosed letter, not a postal card; but it should be borne in mind that the receipt of such a catalogue is a favor, and implies a confidence that it will eventually be of benefit to the sender, and therefore one should have a catalogue file in which to keep them.

Coming to the "ads" your employer put in a new boring mill last week; you will find out something about it here, and more if you will send for a catalogue. It is here you will find the first mention of all new tools, instruments, or contrivances to help you in your job, or to help some other fellow to get your job if he knows more about them than you do. Not until each page has been thus studied can the paper be filed with the certainty that you have received all you can get from it.

As to the boss; it is bad medicine to torm the habit of thinking that any man above you is there by reason of anything else than sterling merit. Seek to see his good points, he has them you may be sure, and they are the blocks with which he builds. Above all, regard him as a man from whom you have much to learn, and proceed to learn it.

"EXPERIENCE."

* * *

MANUFACTURING CONDITIONS IN CALIFORNIA.

Mr. P. E. Montanus, president of the Springfield Machine Tool Co., has been traveling in the far West in the interests of the company, and in a letter dated February 4, at San Francisco, he writes regarding manufacturing and labor conditions in two large shops, from which we quote the following:

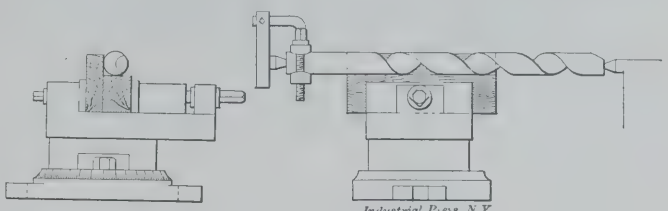
> "Yesterday I visited the big shops of the Southern Pacific Railway at Sacramento, and was cordially received by Mr. T. W. Heintzelman, superintendent of motive power, and Mr. H. H. Forney, master mechanic. I was personally conducted through these great shops where 2,700 men are employed. Wages are high. Lathe and planer men receive 35 cents an hour. These shops do not build locomotives, but repair about twenty-two a month as an average. They build new freight cars, oil tanks, and passenger cars, however. The machine shop equipment is fairly good and modern on the whole, although I saw one Bement & Dougherty planer (about 72 in. by 72 in. by 24 ft.) that has been in constant use since 1849, when it was brought around the Horn. They also have lathes in use that are thirty years old, and the foreman said they were better than some modern makes. At these shops they make a fine grade of cast iron, largely from English pig. As is the case at the Union Iron Works at San Francisco, they make a great many small details like screws, nuts, bolts, oilcups, etc., which I think they can buy much cheaper than they can manufacture. The buildings are very extensive, well-built, and practically arranged, but I think they are poorly located, on account of the labor market. They necessarily must pay the highest wages.
>
> "California has great possibilities for manufacturing and trade will improve year by year if not set back by the labor question, which now is in bad shape. You have probably heard that the Union Iron Works at San Francisco recently lost a contract for a government cruiser, owing to their labor troubles."

CONTRIBUTED NOTES AND SHOP KINKS.

FIXTURE FOR MILLING SLIM DRILLS.

Jas. P. Hayes, Meriden, Conn., writes: In milling a spiral groove in slim pieces, for making twist drills, it is difficult to support the work under the mill with the ordinary rests furnished with universal milling machines.

In the sketch is shown an ordinary milling machine vise which is clamped to the table of the machine between the centers. Two pieces of hard wood of the proper width and thickness and of a length adapted to the length of the work, are held between the jaws of the vise in such a position as to support the work underneath and at one side forming a rigid support against the downward and sidewise pressure of the cutter. I have used this "kink" with very satisfactory results when making long drills for drilling wood, which are made with one groove, similar to a ship auger. This style of drill will drill a straight hole in wood regardless of the direction of the grain.



Industrial Press, N.Y.

A NOVEL TAPER SOCKET.

P. B. sends a "kink" illustrating a rather unusual method of holding tapered shank drills. He writes: We used to have a great deal of trouble caused by twisting off the tangs of drills, so I designed a very simple socket that will prevent this without fail. The "kink" consists in milling a flat on the shanks of the taper and making a socket that will fit these shanks. Now the point is to make a drill socket of this description that will be just about as cheap as the ordinary taper socket. To do this a 1¼-inch hole is bored in a solid block of steel and a ⅜-inch slot cut into the hole from one side, as shown in Fig. 1. The drill sockets are turned to 1¼-inch diameter and bored and reamed for the size of shank that is to be used. The pressing mandrel (Fig. 5) is then put into the socket and the socket put into pressing block and placed so that the flat on the mandrel is just below the slot in the block. The key, shown in Fig. 2, is then put into the slot and the whole placed in a fifty-ton hydraulic press where the side of the socket is pressed down to conform to the shape of the mandrel. After pressing, the socket is put into a lathe and turned to its finished shape (Fig. 4), the end being held by the plug shown in Fig. 6.

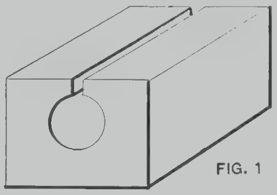


FIG. 1

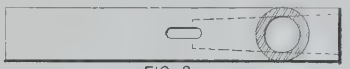


FIG. 3

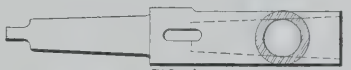


FIG. 4

FIG. 2

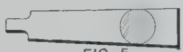


FIG. 5

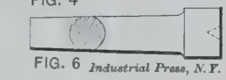
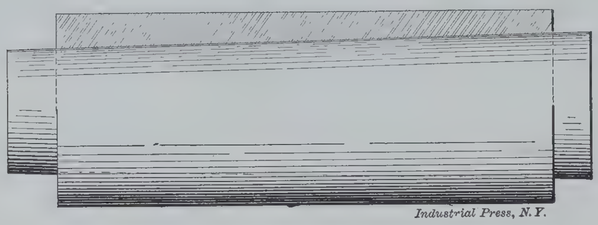


FIG. 6 *Industrial Press, N.Y.*

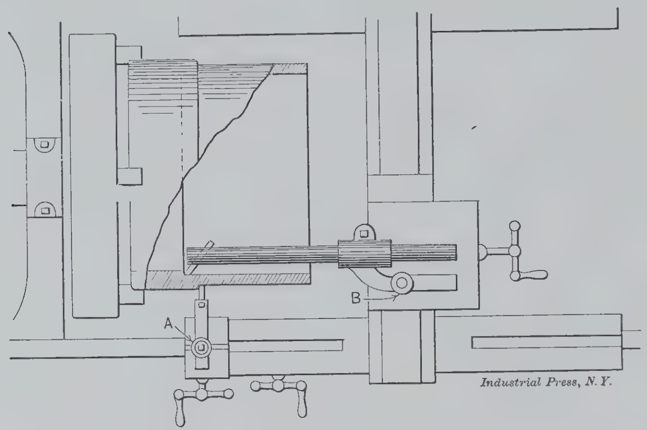
MAKING THRUST ROLLERS.

G. H. H. sends a "kink" regarding which he says: In making conical rollers for thrust bearings of large size, such as are used on heavy machinery and guns, it is of course necessary not only that all rollers be of the same taper but that the diameter at the large and small ends shall be the same in each roller. To produce the same taper on all of the rolls is a comparatively simple matter, requiring only that the grinder be set properly in the beginning. To obtain the same diameters on this taper would be a matter requiring considerable skill except for the simple manner in which it is accomplished. This consists in grinding the rolls first, for which operation the pieces are left considerably longer than finished length and are ground as nearly the required diameter as can be done without fine measurements. The roll is then slipped into a gage which is bored to the same taper as the roll and is of just the length of the roll when finished. With this gage in place the roll is cut off flush with the ends, thus insuring duplication of length and diameter at the ends.


Industrial Press, N.Y.

TURNING AND BORING SIMULTANEOUSLY.

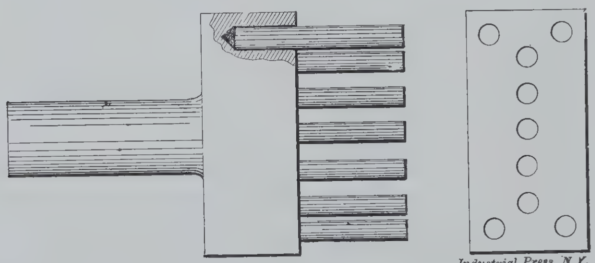
A. McA. writes: We had a large number of bushings which were to be finished both outside and inside, and one of the men suggested that the boring and turning be done simultaneously. In order to do this a compound rest, from another lathe, was mounted upon one end of the carriage and the turning tool mounted in the tool post *A*. The boring tool was held in an ordinary boring tool holder in the tool post *B*. The arrangement will be clearly seen by reference to the accompanying sketch. In this way we were able to do the work in a very satisfactory manner in about two-thirds of the time that would be required by the ordinary method. This scheme may also be used to advantage for turning piston rings or similar work.



Industrial Press, N.Y.

MAKING A PUNCH FOR THIN METAL.

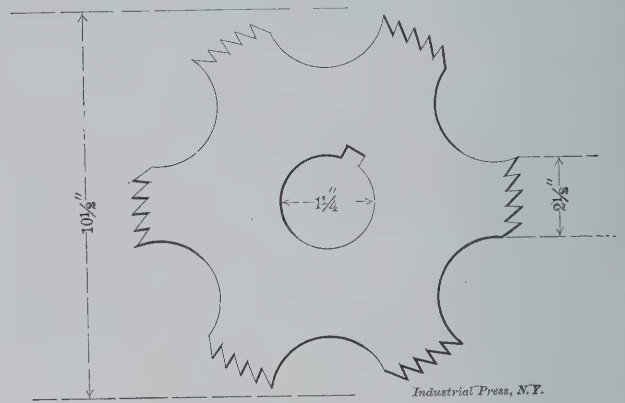
"Teddy" sends us a "kink" in regard to making a punch which is somewhat out of the ordinary. He says: I had occasion to make a punch for cutting a series of small holes about 3-16 inch in diameter and, as the most economical way to do the job, I used pieces of Stubs steel wire fitted to a cast iron punch plate as shown in the sketch.


Industrial Press, N.Y.

The method of setting these punches was somewhat odd, at least it seemed so to me when I first saw it done, but it is all right and works perfectly satisfactorily on punches for thin metal. Holes were drilled in the body of the punch plate relative to the die and about 1-64 inch larger than the wire used for the punches. These holes were then filled with soft solder and the plate leveled in a vise. The punches were well tinned and placed in the die. After heating the plate so that the solder would run, the die containing the punches was placed over the plate and the punches tamped to the bottom of the holes. After cooling the tool was ready for use and I have never seen one of the punches come loose.

A HOME-MADE MILLING SAW.

E. J. Buchet, Dubuque, Ia., sends a sketch of a circular saw, concerning which he says: We needed a saw for cutting some piston rings, on the milling machine, and as we were in a hurry and had nothing else at hand we made it from an old circular saw which was about one-quarter inch thick. We first made it with teeth all around the circumference, of about one-half inch circular pitch. Four attempts were made to temper it but it warped so badly that we gave it up for a bad job. We then tried making it as shown in the cut, having the teeth arranged in sections of five teeth each and tempering one section at a time, drawing the temper with an alcohol blow lamp. In this attempt we were very successful, producing a saw which, when ground slightly concave for clearance, did very satisfactory work.



Industrial Press, N.Y.

A SCALE AND SQUARE ATTACHMENT.

M. H. Ball, Watervliet, N. Y., sends the sketch of a device for attaching a scale to a square. He writes that the combination makes a very convenient tool to use when setting up work for keyseating, as is illustrated in Fig. 2, in which *S* is the shaft to be splined and *C* the milling cutter. It is also a very handy tool for truing up work on the boring mill or lathe.

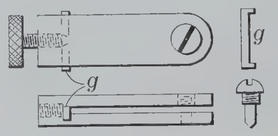
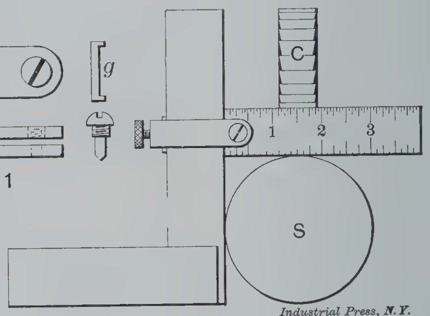


Fig. 1



Industrial Press, N.Y.

Fig. 2

Fig. 1 shows the construction of the parts, which are made of dimensions to suit the size of the scale and the square. For the combination to be successful, it is essential that the blade of the square be the same thickness as the scale.

* * *

The *Practical Engineer* quotes from some source the following note which, if correct, should be of considerable practical value where trouble is experienced from the clogging of flues and chimneys by the soot of soft coal: "Zinc is a peculiar metal in many respects. It volatilizes easily, and the oxide thus produced has a strong affinity for carbon. If one's surface chimney is clogged up with soot, and the owner desires to get rid of it, all that is necessary is to throw a little zinc scrap into the fire. Any old zinc will do, and very little will suffice to keep the chimney clean if used about once a week. The vapor of zinc oxide seizes upon the carbon of the soot and forms a new chemical compound, part of which goes up the flue and part falls to the bottom, to be shoveled out as ash."

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

12. J. E. C. I should like to ascertain if antimony or any other metal (contrary to the action of most metals), will contract with heat and expand with cold.

A. There is no metal, so far as we know, which will do this. A composition composed of 9 parts lead, 2 parts antimony and 1 part bismuth, will expand when cooled from a liquid to a solid state and is sometimes used to fill blowholes in castings because of this property.

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13. G. H.—In planing a slide valve and seat should the cut be across or with the direction of motion?

A.—Valves and valve seats should always be planed *across* the direction in which the valve is to move. In this way the tool marks are worn down to a smooth surface, while if they run in the direction of valve motion they tend to wear deeper and cause the valve to leak. In small engines where the sides of the valve seat form a guide for the valve the sharp corner makes it impossible to plane the seat in the proper way so that great care should be exercised in scraping the seat to a perfect surface. The present practice is to do this work on the milling machine, thereby avoiding the long tool marks while the marks of the milling cutter are such that they very readily wear together.

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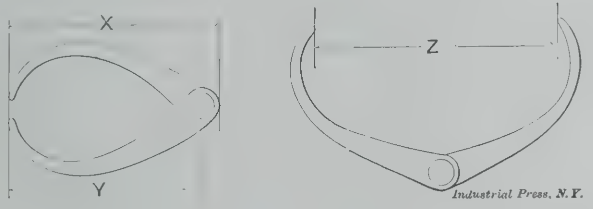
14. E. T.—1. What is the proper form of lathe tool to use for turning and facing rubber rolls, 8 inches in diameter and 14 inches long? 2. When speaking of a certain size of caliper do the catalogs mean the length of the legs or the maximum diameter of the work which they are intended to measure? i. e., in a 6-inch caliper would the dimension X, Y or Z be 6 inches?



Industrial Press, N. Y.

A.—Hard rubber is one of the most difficult substances known to machine and it is practically impossible, with steel tools, to produce accurate work. Some peculiar property of hard rubber, developed by the combination of ingredients necessary for vulcanizing, causes it to blunt the edge of the hardest and best tool steel so quickly that it is hardly possible to machine even a small piece with accuracy. In works where any great amount of rubber turning is to be done black diamonds, or carbons, mounted in steel holders are used with very satisfactory results. These are quite expensive but have good wearing qualities and are capable of producing very accurate results. 2. This question was referred to nearly all of the manufacturers of calipers and with one exception they state that the rating refers to the distance, Y, from the center of the spool or rivet to the point of the leg, while the capacity is somewhat in excess of this. The one exception stated that the rating referred to the capacity of the caliper but that this was usually equal to the distance from the center of the pivot to the point of the leg.

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15. L. E. V.—Will you kindly inform us what acids are employed for pickling castings and the methods employed in using the same? We desire this information to apply to large as well as small work.

Answered by Mr. H. E. Field, Ansonia, Conn.

A.—Two acids are now in general use for pickling castings. Sulphuric acid, or vitriol, and hydrofluoric acid, under various commercial names. The action of these two acids in pickling is entirely different. The vitriol soaks through the sand on the outside of the casting and attacks the iron beneath, and, thus loosened, the sand falls from the casting. The hydrofluoric acid acts directly upon the sand, and dissolves it from the outside of the casting. The use of sulphuric acid is much more general and is more convenient in many ways. It requires but two tanks, one for acid and one for water. Hydrofluoric acid requires for pickling purposes three to four tanks. One for acid, one for water, one for an alkali, and sometimes a fourth for water. The arrangement of the tanks, and method of handling the castings, depend wholly upon the amount of castings to be handled. Small foundries, where but comparatively few castings are pickled, are usually fitted up with a tank filled with vitriol, with a sloping shelf on the sides. The castings are placed on these shelves and the vitriol is poured over them with a wooden dipper and the acid allowed to drain back into the tank. This is repeated until the sand is loosened. The castings are then rinsed in water. An inexpensive device may be arranged by having the shelves surrounding the tank work on a bearing in the center, and tip both ways. While the acid is on the castings they slant toward the acid tank; when they are to be rinsed with water, the shelf is tipped slightly the other way by a lever, and the water is turned on them by means of a hose or pails. In foundries where a much larger number of castings are handled, more extensive arrangements are necessary. Small cranes are used to lower the shelves of castings into the tanks where they are allowed to remain until the sand has become loosened. They are then lifted from the tanks, the acid allowed to drain off, when they are conveyed by the crane to a tank of water, in which they are immersed, to rinse off the acid. The length of time which the castings should be left in the acid depends entirely upon the practice in that particular foundry. Hot iron will eat into the sand more than dull iron, and the castings will require a longer pickling. Heavy castings will require a longer time in the acid than lighter ones.

When hydrofluoric acid is used the castings do not require to be left in the acids as long as when vitriol is used. In this case the shelf containing the castings is lifted from the acid, lowered into a bath containing water, and rinsed, then carried to a third bath containing an alkali solution, and finally rinsed with water. The soda solution is necessary on account of the strong action of the hydrofluoric acid. The necessity of this third washing has prevented a more general adoption of hydrofluoric as a pickling acid. Where the conveniences make its use practical it has been found to be very satisfactory. The above applies wholly to the smaller class of castings. It is more economical to lead the molds for larger castings than it is to pickle the castings afterward. When the molds for heavy castings are not leaded the heavy mass of iron eats so far into the sand as to make the removal of the sand by acids a long and tedious process, and one which is resorted to only when, through improper blacking, the iron has eaten into the sand.

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16. A. M.—I have recently had an opportunity to examine the patent reports in a public library and was surprised to find so great a number of patents on rotary engines. As many as 90 have been issued in one year, and nearly 600 in ten years. As I have never seen but one rotary engine, and the *outside* of that, I was interested in reading the claims and examining the drawings of the patents to find what the *inside* construction of some of them looked like, and found great similarity in the different designs. Now what I want to know is, what is the matter with the rotary engine? Are the difficulties financial, mechanical or otherwise? Can you refer me to some good book on rotary engines?

A.—There have doubtless been rotary engines invented that, if properly worked out, would have given excellent satisfaction, though we believe not as good satisfaction as the reciprocating engine, except, perhaps, for some special uses. The main reason why the rotary has gained no headway is because there has been no demand for it. Many have imagined that there was some mechanical loss of power involved in converting reciprocating motion into rotary motion, which would be done away with in a rotary engine. As a matter of fact, the only loss of power in the reciprocating engine comes through friction, which must exist in any engine, and which might or might not be as great in the rotary as in the reciprocating type. The ordinary engine has been found well adapted to hard and continuous usage, is easily constructed, and can be so designed as to operate with the consumption of but little steam. There is no probability that a rotary engine would be particularly better in respect to the friction loss or any of the other points mentioned than its older rival, and so, as we say, there has been no demand for its development except in the minds of inventors. Beyond this, there are certain mechanical difficulties in the way of the rotary engine which would tend to hinder its introduction, as follows: First, it is not easy to design a rotary engine to cut off steam at any desired point in the stroke, so as to produce what is called an automatic engine, although this has been done in a number of instances. Second, the diameter of a rotary engine increases directly as the power; that is, if a 10 horse power engine were two feet in diameter, a 20 horse power engine of same width or thickness and running at the same speed would have to be four feet in diameter. With a reciprocating engine, the power increases as the square of the diameter and doubling the diameter quadruples the power. Third, the sides of a rotary engine which constitute the rubbing surfaces are in the form of concentric rings of different diameters, points in the outer rings traveling much faster and wearing faster than those in the inner rings. We would therefore not expect a rotary to have the best of wearing qualities. Fourth, to use steam economically the surfaces of an engine which are alternately heated by the hot steam from the boiler and cooled by the exhaust steam should be as small in extent as possible, in proportion to the quantity of steam used, in order to reduce the condensation of the steam in the engine. This is a vital point that is not considered in most rotary engines. As far as we know, no rotary engines have ever been built to develop any considerable power. We have never heard of one as large, even, as 100 horse power. As explained above, however, it would be necessary to build them of very large diameter for large powers, unless they were designed to run at very high speed. In the past there has been no market for very high speed motors, because it has always been necessary to belt down the speed before machinery of any kind could be driven. With the introduction of alternating current motors and generators, however, there has come a demand for high speed engines to drive the generators, which the present type of large reciprocating engine is not well adapted to fill. The outlook for the rotary engine of the future, therefore, would seem to be brighter than its record in the past, were it not for the fact that it has a worthier and more successful competitor in the steam turbine. While there are some problems difficult of solution in connection with the turbine, it seems to have every advantage of the rotary engine and but one of its disadvantages—high speed, and to have certain features of value all its own. There is no book published on rotary engines.

* * *

A writer in the *Scientific American* suggests that plumbago packing rings of special design could be profitably employed in superheated steam engines, gas engines, and other heat motors in which a high temperature is employed. Plumbago, or graphite, is unaffected by heat and is capable of being molded into permanent form suitable for packing rings, which are now uniformly made of metal. The chief expected advantage is the mirror-like surface and polish that such rings would impart to a cylinder.

MOTOR DRIVES FOR RADIAL DRILLS.

Last month were published illustrations and descriptions of standard planer drives for electric motors recently adopted by the Gray Planer Co., Cincinnati, O. The Bickford Drill and Tool Co., Cincinnati, have adopted a similar plan for their radial drills and the illustrations herewith show three standard motor equipments that are now regularly provided. In Fig. 1 is shown a radial fitted with a constant speed motor set on an extension to the base. Power is transmitted to the gear box by means of a Renold silent chain which, through the use of suitable sprocket wheels, gives with almost any make of motor correct speeds for all sizes of drills given on the standard speed plates furnished with the radial. The drill is driven through the speed box at the base of the drill column by which the speed variation is obtained. The starter and cut-out for the motor are located just back of the gear box.

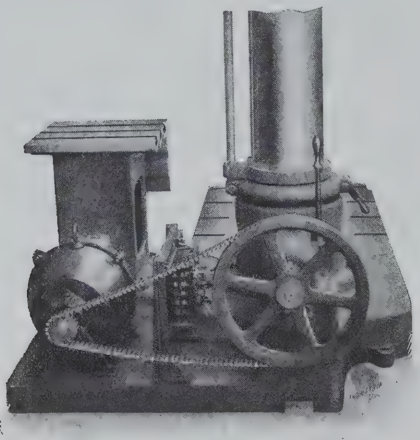


Fig. 1. Constant Speed Motor and Chain Drive.

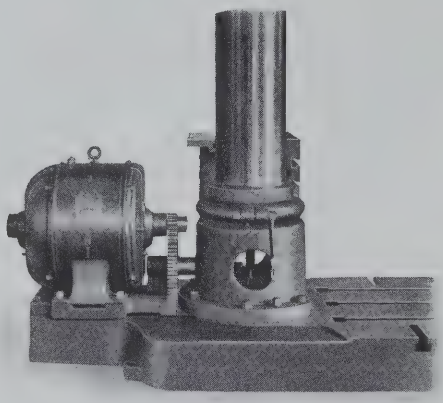


Fig. 2. Variable Speed Motor and Geared Drive.

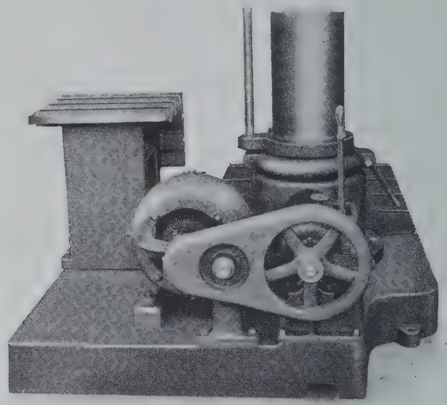


Fig. 3. Constant Speed Motor with Change Gear Drive.

In Fig. 2 the radial is driven by a variable speed motor in which the speed changes are obtained by inserting resistance in the field circuit. The motor sets on a bracket made to fit the standard base of the drill and transmits power to the machine through a single pair of gears which, by means of a rheostat and the back gears gives approximately correct speed for all sizes of drills from a ½-inch to a 3½-inch drill.

Another equipment, Fig. 3, retains the gear box for speed variation with a constant speed motor, but instead of using the chain the power is transmitted to the gear box by means of two spur gears and a rawhide pinion which, by merely altering the number of teeth in the pinion to suit the speed of the motor it is desired to use, furnish a correct range and graduation of speeds for all sizes of drills given on the standard speed plates.

* * *

One of the troubles incident to the operation of third-rail electric traction systems arises from accumulation of ice on the third rail during sleet storms. The effect of the ice coating is to interpose a film of high resistance between the collector shoes and the charged rail, which seriously impairs the efficiency of such systems, causing sparking and loss of contact. New Yorkers had a painful illustration of this recently on the Manhattan Elevated Railroad. Another serious objection to the third-rail is its danger to workmen on the track. On the Manhattan Elevated Railroad two heavy timbers are located close to the rail on each side to prevent objects falling on the rail, or the workmen carelessly stepping upon it, but these are not sufficient safeguard, as proven by a number of accidents. What puzzles the lay mind is why the rail on this system is not protected by some sort of a ledge or roof open at one side to allow the conductor shoe to come in contact. While such construction would not be a total preventative of trouble from ice storms, it would largely mitigate it, and would reduce danger to workmen to a minimum. What promises still better is an inverted third-rail system invented by L. E. Walkins, Springfield, Mass., in which, as the name implies, the rail is turned upside down in an insulated trough, the conductor shoe making contact from the bottom. The rail and its insulation sheath are supported by steel brackets located about 15 feet apart.

A FRICTION WATER WHEEL GOVERNOR.

In using the turbine for driving electric generators a most efficient regulator is needed to meet the exacting requirements of electric light, power and railway service. For this purpose turbine governors of various styles and makes are now in use and from time to time new designs are being perfected for obtaining closer regulation and more constant speed. The regulator which is here illustrated was built by the Woodward Governor Co., Rockford, Ill., and has proved very successful after a severe test at the three-phase power plant of the United States arsenal at Rock Island, Ill., where three governors are used with fourteen 50-inch turbines. These governors are required to close the gates from full open in six seconds and with the severe changes due to the operation of large induction motors the greatest temporary fluctuation does not exceed three per cent.

In another plant at Quebec, two governors are employed, each controlling four 51-inch horizontal cylinder gate turbines and operating the full range of the gate in five seconds. These cases serve to illustrate the class of work that a turbine governor has to perform.

This governor is driven by a belt, from the line shaft of the installation, running on the large pulley shown at the back in Fig. 1. Secured to the main shaft, which is driven by this pulley, is a compressed paper friction disk. On each side of this disk is a friction pan, the hub of which is cut as a pinion for driving the large spur gears shown on the operating shaft at the front of the machine. The main shaft, upon which the paper friction is mounted is free to slide in its bearings so that the friction disk may be forced into contact with one or the other of the friction pans. When it is forced into contact with the right-hand pan the pinion upon the hub drives one of the large gears and causes the shaft to revolve in the proper direction for closing the gate. When the disk is forced into contact with the other pan the operating shaft is driven through the medium of an intermediate gear, and it is caused to revolve in the opposite direction, thus opening the gate wider. This constitutes the regulating action of the governor and it is controlled by the governor proper, which is shown in detail in Fig. 2.

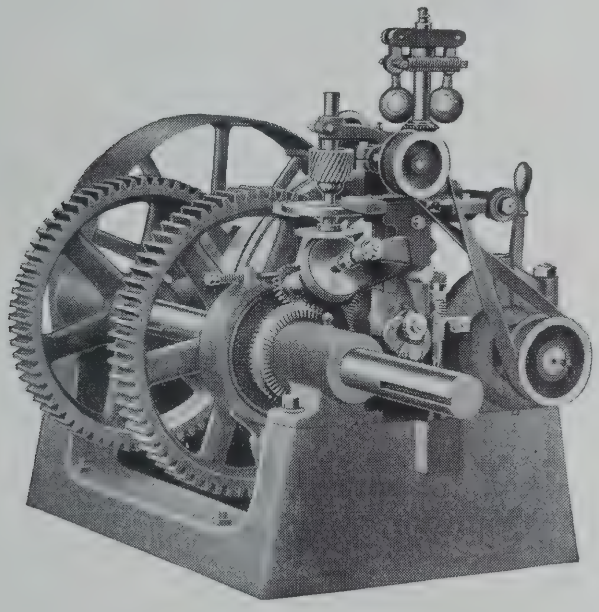


Fig. 1. Woodward Water Wheel Governor.

The speeder balls are driven independently from the main shaft of the installation by a belt running on a pulley at the back of the column. In front of the column is a cam which revolves constantly, being driven by a cross belt from the main shaft and a spiral gear. Above and below this cam will be noticed two arms or tappets which project inward toward the center. When the speed is normal the cam revolves between these tappets without engaging either of them. With a variation of the speed and a corresponding elevation or depression of the speeder balls, the vertical shaft of the speeder raises or lowers, carrying with it the tappet arms and tappets; and one or the other of them, depending upon whether the speed is slower or faster than the normal, engages the cam and is immediately forced out from the center. This motion is transmitted through suitable crankshafts to the main shaft, on which the friction is mounted, and it is forced into contact with the opening or closing friction pan. This causes one or the other of the pans to revolve, as before described, and operates the turbine gate.

The cam mechanism is capable of very close adjustment, enabling the governor to act on so small a change of speed that for the ordinary conditions of lightning service, no perceptible variation of speed will be allowed. At the same time the governor will not act upon the gate when the speed and load are steady, and consequently there is much less wear on the gate mechanism than with a governor that keeps the gate in continuous motion although so slight as not to affect the speed.

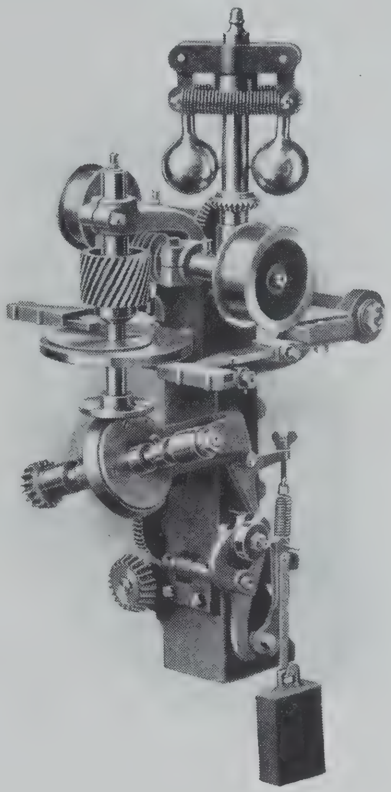


Fig. 2. The Controlling Mechanism of the Woodward Governor.

In hydraulic regulation, as well as in the regulation of steam, some mechanism is required to prevent the governor from racing and in this controller this is provided for by the disk and compensating wheel shown at the front of the column. The disk, which is fastened just below the cam and revolves with it, is concave and rests upon the periphery of the compensating wheel. The oblique shaft which carries the compensating wheel is geared, at its lower end, to the operating shaft so that it revolves only when there is a movement of the gates. The shaft is provided with a square thread and the wheel, which is tapped to match, rides upon the threaded portion.

In operation, the principle is as follows: When the speed is normal the compensating wheel seeks the center of the disk which is supported upon it because this disk is constantly revolving with the cam. When a movement of the gates occurs the compensating shaft is revolved and the wheel will travel along its shaft in such a direction that it will separate the cam from the tappet when the gate has been moved to that point which will give the correct speed, after the momentum of the machinery has been overcome. During this interval the disk will return the compensating wheel to the central position. This device can be designed to properly compensate for any condition, as the time element can be varied, not only by varying the pitch of the screw, but also by varying the speed of the oblique shaft with a change of gears.

* * *

Better have a poor mill under a good foreman than a good mill under a poor foreman.—*The Wood-Worker.*

BEARINGS FOR LIGHTHOUSE LENSES.

One of the problems often confronting the engineer is to provide a suitable bearing for a vertical revolving shaft and when this shaft carries a heavy weight at its upper end and revolves at a high rate of speed the problem becomes one of considerable consequence. In no place is a bearing of this nature put to more severe test than where bearings are used to support the heavy lenses of the revolving lights in a modern lighthouse. Through the courtesy of the United States Lighthouse Board we publish the following description of the bearings used for this purpose:

Under the old system of revolving lights, which is still largely in use, the lens is supported by an arrangement known as a chariot and upon which it turns. This consists of a number of wheels connected together and running upon a circular steel track placed on top of the lens pedestal. Usually there is another set of friction wheels fastened below the baseplate of the lens, but running horizontally against a vertical collar, the object of which is to prevent lateral motion. The best speed obtained with this arrangement for the higher order of lenses, viz., the 1st, 2d, and 3d orders, is about one revolution in two minutes, and for the lower orders —4th, 5th, and 6th—about one revolution in one minute.

With the introduction of the new system of "lightning lights" with lenses consisting of but one, two, three, or four panels—instead of the old style many-sided lenses—and giving flashes of about 1-10 of a second duration at intervals of five seconds—it was found that the chariot was altogether unsuited for the purpose, because it developed too much friction, and the problem was solved by supporting the lenses upon an annular cast-iron float in an annular cast-iron vat or pot—both neatly turned—containing mercury, the free or clearance spaces between the two being about ⅛-inch on the sides and about ¼-inch on the bottom.

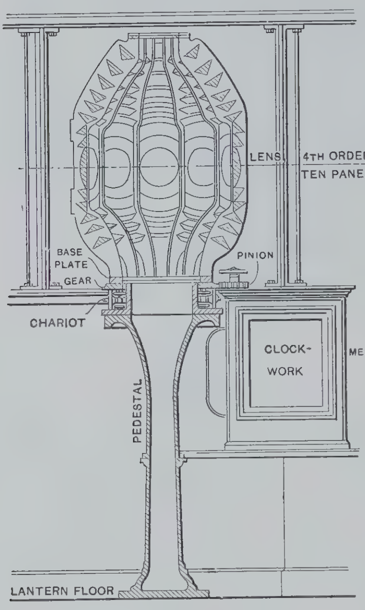
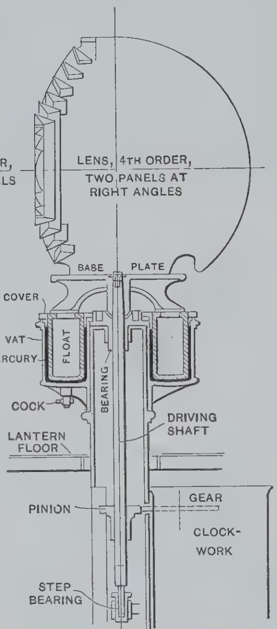


Fig. 1. Chariot Bearing.



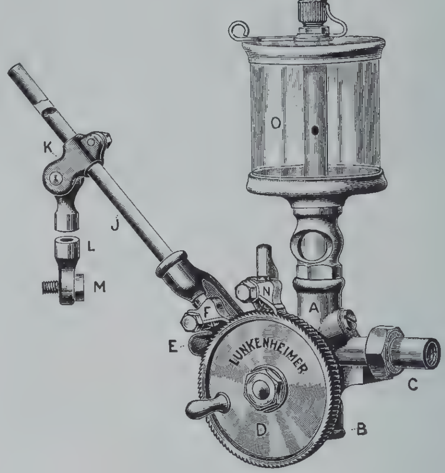
Industrial Press, N. Y.

Fig. 2. Mercury Bearing.

In order to prevent lateral motion and rubbing between the float and vat, the horizontal friction wheels, mentioned above, are sometimes retained, but more generally the object is accomplished by a vertical shaft, the pressure on whose toe, due to the weight of the lens, is almost wholly relieved by the buoying effect of the mercury. Usually the vat is arranged so that it can be lowered for examination and repair, and a cover is provided to prevent foreign substances from falling into it. It is customary to cover the mercury with a layer of paraffin oil so as to prevent evaporation. By this arrangement the friction is reduced to a minimum, being probably a little more than that between the mercury and the turned cast-iron float, and enabling speeds of about one revolution in ten seconds in the higher orders, and of about one revolution in four seconds in the lower orders to be obtained.

A MECHANICAL OIL CUP.

In many cases where there is a demand for something more reliable than hydrostatically operated lubricators, a mechanically operated oil pump has been found very satisfactory. The advantage of this method of lubrication is that the oiling is absolutely positive and all of the oil that is fed to the pump is bound to be forced into the steam chest or cylinder of the engine. The mechanical oil cup, shown in the illustration, has connected to it a small pump which is operated by the rotation of the crank disk *D*; the disk being driven by means of the ratchets *F* and *N*. To operate these ratchets the rod *J* is connected to one of the eccentric rods, or other moving part of the engine by means of the couplings *K* and *M*. By moving the part *K* up or down the rod, the stroke of the pump can be lengthened or shortened, as desired, thus regulating the amount of oil fed by the pump independent of the feed from the oil cup.



Mechanical Oil Cup.

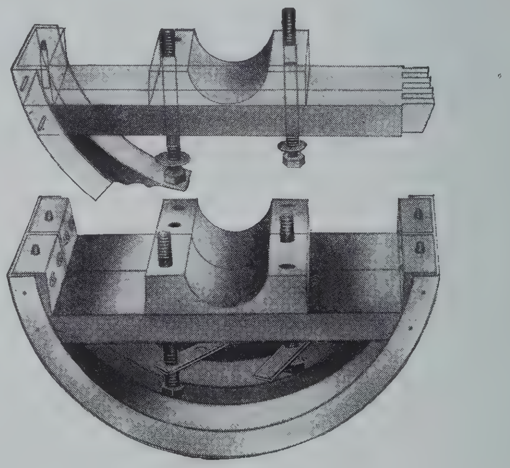
The ratchet wheel *D* is provided with a handle whereby it can be rotated by hand in case it is desirable to force a quantity of oil at any time, as, for example, when starting the engine.

The bottom of the pump body, *B*, is tapped to receive a stud, so that it can be placed in any desired position, and the outlet, *C*, is piped to the steam chest or steam pipe of the engine. This cup is the product of the Lunkenheimer Co., Cincinnati, Ohio.

* * *

THE HERCULES STEEL FACE PULLEY.

One of the latest developments in the line of wood pulleys is the Hercules steel face pulley, shown in the cut, which is the product of the Smith Stamping Factory of the Federal Manufacturing Co., Milwaukee, Wis. This pulley is constructed with a wood center and arms, and has a face formed of a double flanged steel ring, which is securely fastened to the wooden arms both by bolts through the face and by rivets through the flanges. This pulley is made in halves and is very light, thus possessing the advantages of the wood split pulley, while the steel face gives it the strength and wearing qualities of a steel pulley.



NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

MANUFACTURING MILLING MACHINE.

The manufacture of the standard parts in large quantities in gun shops, sewing machine and typewriter factories, etc., has evolved a simple and compact type of milling machine, such as that shown in Fig. 1, which is one of the latest productions of the Garvin Machine Co., New York.

The head, bed and saddle are cast in one piece, making a very rigid construction, and as in machines of this class little adjustment is required, the adjustment provided is confined to the cutters, moving them in and out on the arbor and raising the spindle up and down. The spindle is taper and runs in a solid self-oiling bronze box with hardened and ground thrust washers. It is carried in a large block fitted with taper gibs at the rear and adjusts up and down in the column of the bed. The block is clamped at both ends, at any height, by the bolts at the top of the column. The steel arm is also carried in this block, so that the arm and spindle move together and a substantial brace yoke is provided. The spindle is raised and lowered by the hand wheel, with micrometer reading, at the top of the column and locked by jam nut below the wheel. This construction and method of adjustment is convenient in setting the machine and secures an absolutely solid support for the spindle.

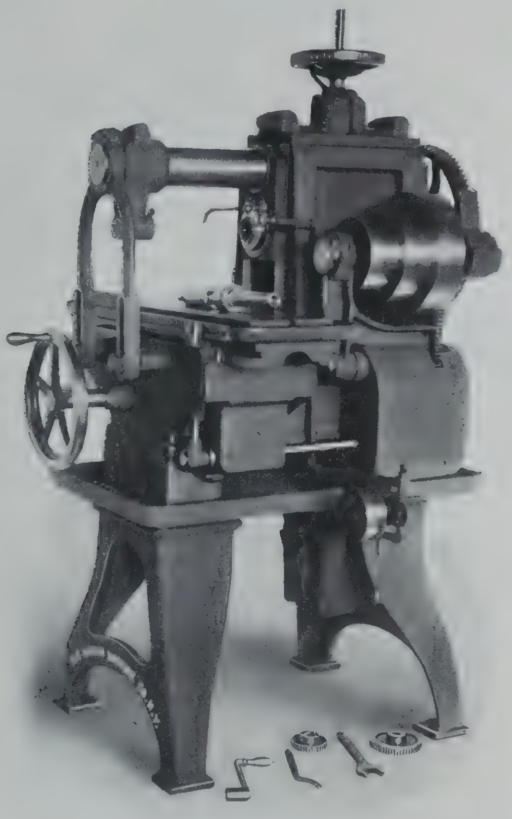


Fig. 1. Garvin Manufacturing Milling Machine.

The arrangement for side adjustment of the collars on the arbor is important and shown in Fig. 2. The shoulder of the arbor is fitted with a fixed notched collar, *A*, each notch corresponding to 1-1000 of an inch. Set up against the shoulder of the arbor is another notched collar, *B*, which locks with the notches in the collar *A*. Screwed on the collar *B*, but keyed to the arbor, is the collar *C*. When the cutters are to be adjusted the nut on the outer end of the arbor is loosened until the collar *B* can be moved out of mesh into other notches in the collar *A*, and then the collar *B* is turned as many notches either way as it is desired to move the cutters thousandths of an inch, and put back in mesh and the whole tightened up again. It is evident that when the collar *B* is turned it will force the collar *C* in or out, and when *B* is put back in mesh with the notches in the fixed collar *A*, the setting is absolutely locked and cannot change. The notched teeth do not bottom, and no strain is transmitted through them in any way. The arbor is held by a draw-in rod.

The back shaft carries a large cone and is fitted with ring oilers and linked to the spindle to maintain gear distance, being geared 5 to 1. The table is wide and deep, and has a large oil space all around with an overflow opening on the inner side. It is fitted with square gibbing and large bearing surfaces on the bed. The feed is positively driven by chain, with tightener, through drop-forged hardened worm gears connecting to the table feed screw. The movement of the table is by screw to secure steadiness, and is fitted with ball thrust for easy quick return by the large hand wheel and quick gearing, which gives a movement of 1½ inch to one turn. The feed is thrown in by the lever at the front end of the saddle and tripped by a knob at the same point. All these trip parts are enclosed in the saddle and removed from contact with chips and dirt. The oil pan is provided with tipping oil pot and fitted with pump and piping, and extension shields are provided to catch all drip from the table. All driving and feed gearing is enclosed.

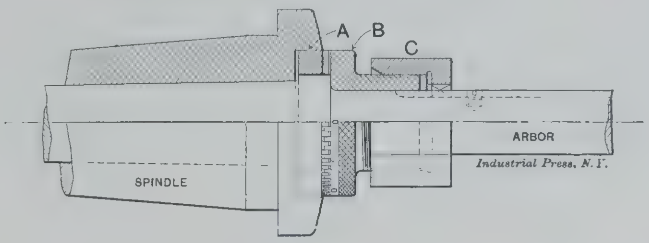


Fig. 2. Spindle of Manufacturing Milling Machine.

SLOTTING ATTACHMENT FOR THE MILLING MACHINE.

The illustrations given herewith show a new slotting attachment for the milling machine which has a number of points that commend it to toolmakers, diemakers or others having use for such a device. Fig. 1 is a photograph of the attachment as it is applied to the milling machine, while the details will be clearly seen by reference to Fig. 2, next page. This attachment had its inception in the shops of the Wm. L. Gilbert Clock Co., Winsted, Conn., where the first one was built from designs made by their superintendent, Mr. Thos. W. R. McCabe, in 1895. Several years ago The Cincinnati Milling Machine Company purchased Mr. McCabe's designs, which were the basis for the design of the attachment shown herewith.

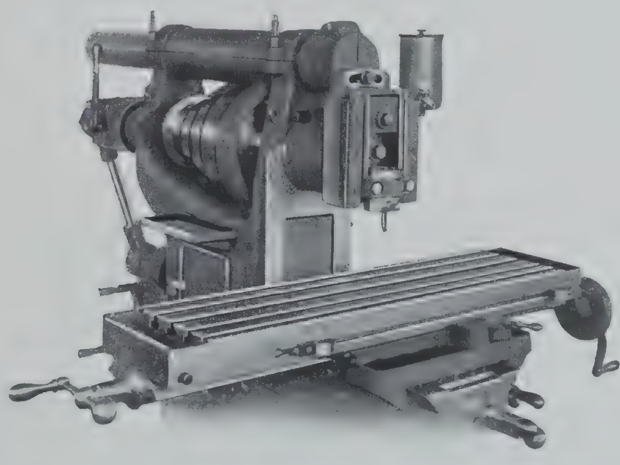


Fig. 1. Slotting Attachment on Milling Machine.

It consists essentially of a housing which clamps to the extension of the front spindle bearing, and is supported by the overhanging arm. A crank disk driven by an arbor held in the milling machine spindle imparts a reciprocating motion by means of a pitman to the slide which carries the tool. This crank has a T slot extending across its face, in which the crank pin is held; and the length of stroke may be varied by adjusting the crank pin toward or away from the center of the crank disk. The attachment may be set at any angle up to 10 degrees on either side of the vertical position for clearing dies, etc. This is accomplished by swiveling it about the milling machine spindle as a center, and since this is also the center of the crank the angularity between the pitman and slide is always constant and the length of stroke is not disturbed by swiveling. The tool is held in a "clapper box" which, in turn, is held in a swivel block that is graduated in degrees and may be swiveled through a complete circle and clamped at any angle. It has a stroke of from 0 to 2 inches on the small sizes, and from 0 to 3 inches on the large sizes. The distance between center of milling machine spindle and bottom of clapper box when it is at the top of the stroke is about 5 inches on all sizes, which gives an unusually large amount of room between the attachment and the top of the table when the latter is in its lowest position. The center of the tool is 9¾ inches from the face of the milling machine column, on all except the attachment for the smallest size miller, and it will be seen from the illustrations that this space is all clear and available for work—there being no parts of the housing that project below the tool holder. There is an adjustable taper gib provided for taking up the wear on the slide. The attachment is made by The Cincinnati Milling Machine Company, Cincinnati, Ohio.

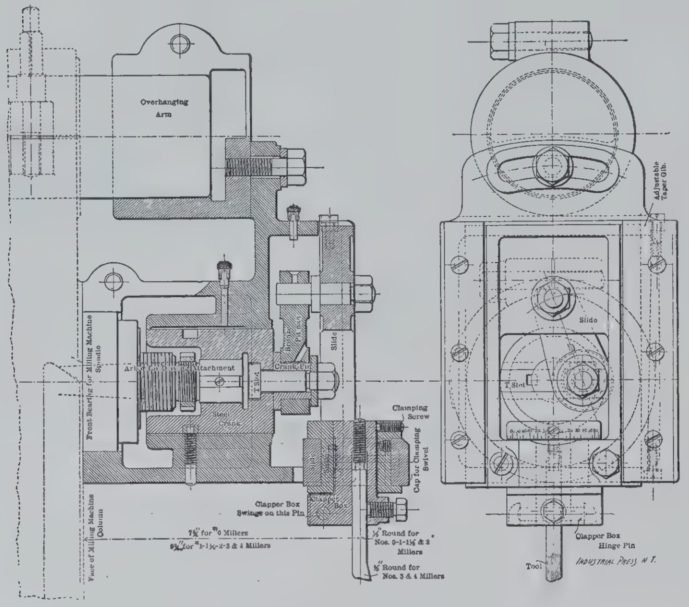
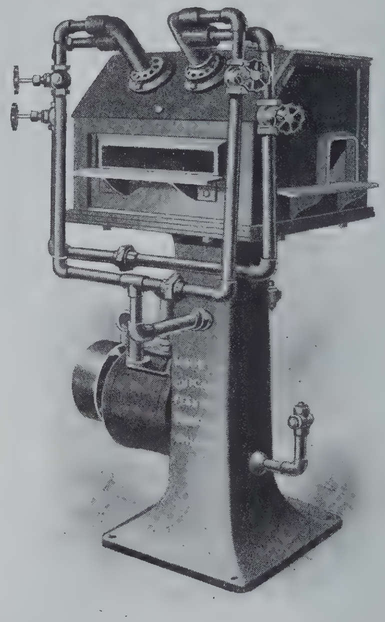

Overhanging Arm
Adjustable Taper Gib.
Front Bearing for Milling Machine Spindle
Arbor for Driving Attachment
Bronze Pitman
Slide
Crank Pin
T Slot
Steel Crank
Slide
T Slot
Clamping Screw
Cap for Clamping Swivel
Slide
Clapper Box
Clapper Box Swings on this Pin
Face of Milling Machine Column
7⅛" for #0 Millers
9¾" for #1-1½-2-3 & 4 Millers
½" Round for Nos. 0-1-1½ & 2 Millers
⅝" Round for Nos. 3 & 4 Millers
Clapper Box Hinge Pin
Tool
INDUSTRIAL PRESS N. Y.

Fig. 2. Detail of Slotting Attachment for Milling Machine.

STEWART MAGNET HEATING FURNACE.

One of the latest productions of the Chicago Flexible Shaft Co., Chicago, is the gas furnace shown herewith. Although designed especially for heating telephone magnets, it is well adapted for handling all kinds of small pieces, of a similar character, that have to be heated in large quantities. The furnace is mounted on a hollow base which incloses a pressure-equalizing air reservoir to which is directly connected a rotary pressure blower of the slow speed type. This makes a very compact arrangement and allows a large capacity for the floor space occupied. The burners are so arranged that the flame is projected diagonally downward against the floor lining and comes directly in contact with the work that is being heated, thus insuring a quick, uniform heat that is under perfect control of the operator and regulated by the valves on air and gas supply pipes. The shape of the linings is such that the heat is evenly distributed and turned to useful effect.

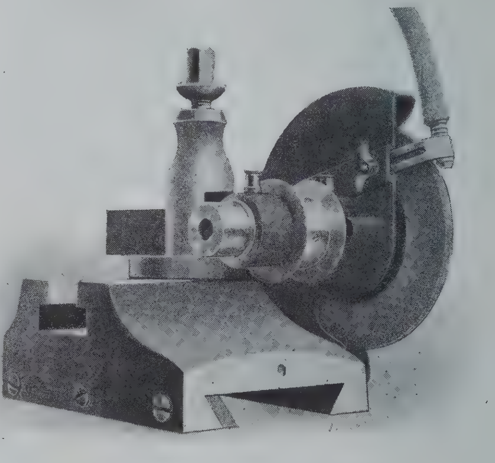
The magnets or other pieces to be heated are placed in the furnace through the long opening in front and when heated are removed through the square opening at the side. In this way the work is continuous and the capacity of the furnace equal to the operator's ability to put in and take out the pieces. This furnace has shown a great economy in fuel over previous furnaces of the same class, and a saving in labor over coke or coal furnaces, of 300 per cent. As high as 1,800 telephone magnets have been heated with one of these furnaces in a single day.



Stewart Magnet Heating Furnace.

TOOL POST GRINDER FOR WET GRINDING.

In shops not possessing an expensive universal grinder very satisfactory results are obtained by the use of the tool-post grinder and its use has become widely appreciated. Up to the present time, however, these grinders have been fitted for dry grinding only and to meet the demand for a wet grinder the Grant Mfg. & Machine Co., Bridgeport, Conn., have produced the wet tool-post grinder that is here illustrated. This grinder has a hardened and ground steel spindle which runs in adjustable bronze dust-proof boxes. It can be placed in the tool-post of an ordinary lathe in the same manner as the dry tool-post grinders. The addition of the water hood adapts it for use with thin cutters or where there is danger of drawing the temper of the tool being ground. The hood is provided with an adjustable water spout so that the water will impinge between the wheel and the work on any size of wheel that may be used. If desired, when dry grinding, the hood may be readily removed. The drum of the countershaft, furnished with the grinder, is made entirely of sheet metal and is perfectly balanced, making a light, smooth-running drum that is safe at all speeds.

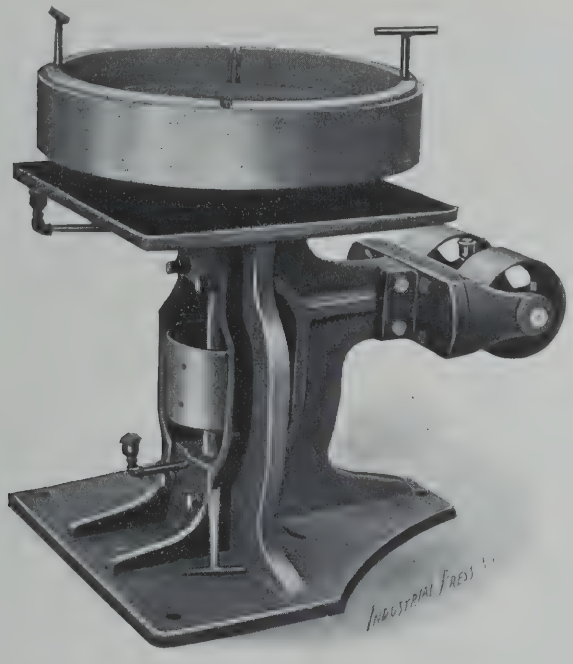


Tool Post Grinder for Wet Grinding.

A VERTICAL GRINDING MACHINE.

The accompanying half-tone illustrates a vertical grinding machine that has just been placed on the market by the Tanite Co., Stroudsburg, Pa., and while not especially novel as a grinder, is of particular interest because of its special adaptation to the use of a particular solid emery wheel that is the product of this company. This wheel, although truly a solid emery wheel is, nevertheless, semi-hard. Instead of being brittle, and ringing like a bell when struck, this wheel is compressible and more or less elastic. It is a mixture of emery and other materials and has about the consistency of a rubber car-spring. It is not as well known as it should be that solid emery wheels of the ordinary kind are not suited to very fine work. It is almost useless to make solid emery wheels of very fine emery, as the vibration of machine, wheel and work produces wave marks and irregularities. Solid emery wheels are in their right place when used for cutting or grinding, but when polishing is needed the wooden wheel, with its band of compressible sea-horse leather coated with emery, seems the proper thing. All good polishing wheels are more or less compressible. In this semi-hard wheel, emery as coarse as No. 24 will produce a finish very much finer than the same emery would if used in a solid wheel.

It was once believed that the semi-hard wheel would be a very great success, but this success was negatived by the discovery that semi-hard wheels could not be run at the standard speed of a mile a minute. It was found that such wheels would do excellent work at half speed. The buyers of such wheels, however, objected to purchasing additional machines and experimented at their own risk by running the semi-hard wheels at the unwarranted full speed, the result being that these wheels expanded from centrifugal force—grew thinner at the center—and became loose on the spindle. Thereupon the grinder at once screwed up his flanges and these expansions and screwings up being progressive the wheel soon burst from centrifugal force and from the squeezing at the center. The Tanite Co. then experimented with a view to making semi-hard wheels which would be safe at the standard speed. The facts incidental to this endeavor throw an interesting light on the strain which a good emery wheel can resist. Wire webs, Manila fiber, and other substances which could be practically introduced into the body of the semi-hard wheel to strengthen it were torn asunder by the immense centrifugal force evolved in the testing speed, which was always double and sometimes treble the standard running speed. A 14-inch wheel with three disks of sole harness leather, 12 inches in diameter, molded in its substance was readily burst at the test speed, the three disks of leather being torn through the center.

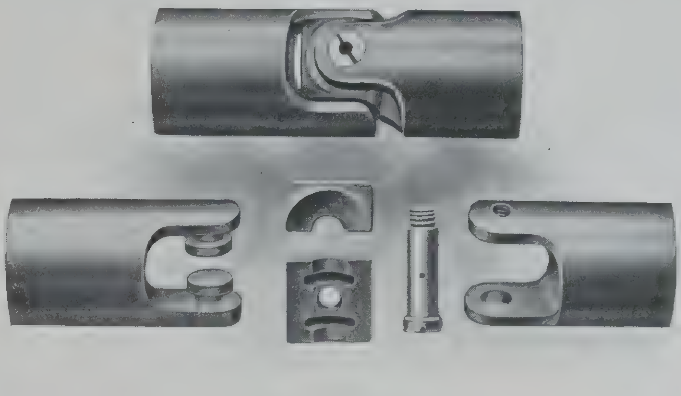


Vertical Grinding Machine.

In the machine here illustrated the semi-hard wheel (with either a plane, curved or cone-shaped surface) is set inside of the metal ring and is thereby prevented from expanding and bursting; it can, therefore, be run with safety at the standard speed. By means of the hand screws the bottom plate of this wheel chuck, or holder, can be raised or lowered so that as the wheel wears it may be raised and kept just equal with or above the rim of the chuck.

A NEW UNIVERSAL JOINT.

The accompanying half-tone shows a new universal joint that has just been placed on the market by the Mutual Machine Co., Hartford, Conn. This joint, which is shown assembled in the upper view and in pieces in the lower, is constructed in a new and unusual manner, tending to increase the strength and efficiency of the joint. Upon one of the jaws are two shouldered pins which are integral with the jaw itself and therefore cannot pull out or work loose. The center block which fits over these locking pins has two grooves for the reception of the heads of the pins. The binding screw by which the joint is fastened together passes directly through the center block at right angles to the locking pins. The effect of the pins in one direction and the screw in the other is to lock the block together firmly and make it impossible for the sides to spring apart, at the same time forming a flexible joint that is free to move in any direction.

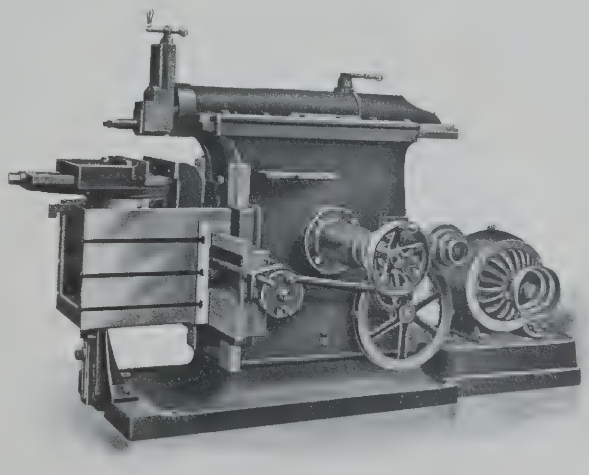


New Universal Joint.

In the center of the block will be noticed a cavity which can be filled with grease or vaseline, thus making the joint self-oiling and requiring attention only at long intervals. A hole through the binding screw communicates with this central cavity, so that oil or lubricant can be introduced without taking the joint apart.

MOTOR-DRIVEN CRANK SHAPER.

The motor-driven crank shaper shown in the half tone is the latest production of the American Tool Works Co., Cincinnati, Ohio. This machine follows the general design of the shapers previously built by them, but has been thoroughly redesigned, extra weight added to base and column, the bearing surfaces increased and oiling facilities improved. The stroke is positive and its length may be changed at will without stopping the machine. The regulation of the stroke is facilitated by an index on the face of the ram. The rocker arm is pivoted near the base line, and this gives the ram an almost uniform rate of speed its entire stroke, and provides an exceedingly quick return, while the back gear ratio gives



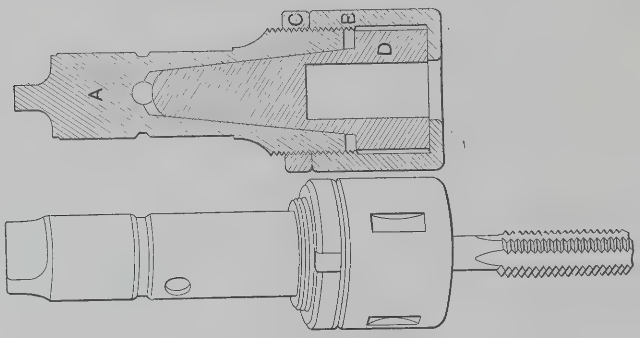
Motor Driven Crank Shaper.

the tool exceptional power in taking heavy cuts. The rocker arm is of double-section pattern, permitting large sized shafts to be passed under the ram, through the hole shown in the top of column, for keyseating.

The motor is mounted on a substantial base directly back of the column. It is of the constant speed type, running at a high speed, the proper variation in cutting speed of the ram being obtained through a pair of cone pulleys. One is mounted directly on the motor shaft, the other on a stud on the column. The cone on this stud carries a pinion which meshes into a large gear on end of driving shaft. This driving arrangement gives the belt a high velocity and has proved very satisfactory wherever it has been installed.

NEW FRICTION TAPPING DEVICE.

The "Hollm" friction tapping device for preventing breakage of taps when the operator neglects to reverse before the bottom of the hole is reached, etc., is probably the simplest device of the kind yet put on the market. It consists essentially of a body *A*, bored with a taper hole, the included angle of which is about 16 degrees, lined with a thin sheet of red fiber composition. Into this taper hole the end of the tap-holder *D* is fitted, and it is driven by the friction developed between it and the fiber lining. The amount of friction and, of course, the force with which a tap is driven, depend on the setting of the cup-shaped piece *B* by which the pressure between the body *A* and tap-holder *D* is regulated. The check-nut *C* holds *B* at any desired setting. This device, which is made in three sizes for large, medium and small taps by the Whitney Manufacturing Company, Hartford, Conn., may be used interchangeably with their "Presto" collets.



The "Hollm" Friction Tapping Device.

TWO NEW CHUCKS.

Of all of the troubles in the machine shop none is more often in evidence than that caused by breaking the teeth of the bevel gears which are used for turning the ring that operates the universal chuck. The construction of the ordinary scroll chuck is such that a very low limit is placed upon the size of these bevel gears and for this reason they are, of necessity, the weakest part of the tool. It is apparent that a spur gear of given diameter and pitch is much stronger and will wear longer than a bevel gear of the same size, so that the substitution of a spur gear and pinion for the customary pinion and rack would seem to remedy this most fruitful source of trouble.

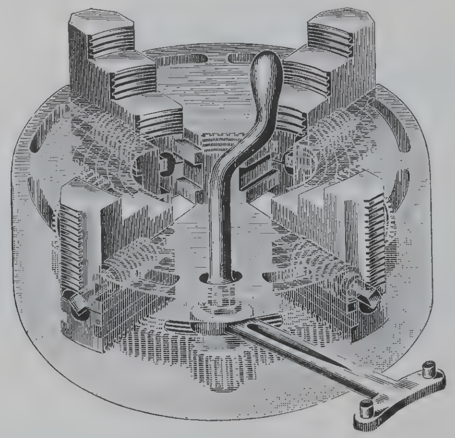


Fig. 1. Spur Geared Scroll Chuck.

A scroll chuck constructed upon this principle has just been brought out by the Westcott Chuck Co., Oneida, N. Y., and is illustrated in the accompanying cut, Fig. 1. The steel scroll by which the jaws are caused to open and close has a spur gear cut upon its edge and this is driven by a strong spur pinion. The end of the pinion shaft is fitted to receive a socket wrench that is applied through a hole in the face of the chuck. After tightening the work in the jaws by this means an open-end wrench may be slipped through a slot in the side of the chuck and engaged with a hexagonal shoulder on the pinion shaft. To this wrench may be applied much more power than it is possible to exert upon a socket wrench. The power of the lathe may be applied to the wrench by allowing the handle to strike the lathe bed. The scroll is manipulated rapidly by means of a lever which engages directly with it at the back. The jaws are reversible.

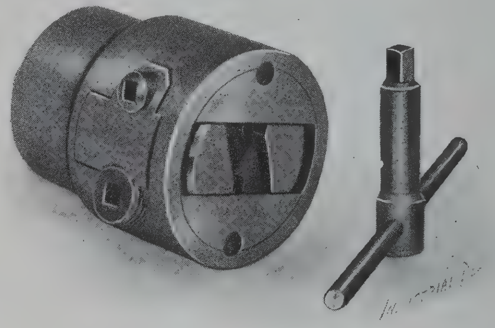
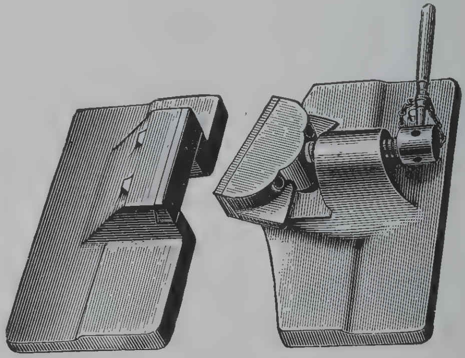


Fig. 2. "Little Giant" Chuck, with Auxiliary Screw.

Another chuck which has been brought out by the same company is the "Little Giant," auxiliary screw, drill chuck. In drill chucks with side screws the inner or gripping part of the jaws has a tendency to crowd away from the right and left hand screw, and the outer end of the jaws tends to draw toward the screw. Such tendency is overcome in this chuck by the use of an auxiliary screw which binds the jaws on the side opposite that clamped by the right and left hand screw. After closing the jaws on the drill in the usual manner, by turning the right and left hand screw, the auxiliary screw is tightened, with the effect of virtually bolting the two jaws together.

MASSEY'S DIVIDED VISE.

One of the latest productions of the Massey Vise Co., Chicago, is the divided vise, a cut of which is shown below. This vise is intended for use on the planer table, where the two halves can be fixed at any desired distance apart, for holding pieces of any desired length or width. The work is simply dropped into the vise, which is screw-tightened up, and the bevel jaws, which are peculiar to the Massey vise, force it down hard and evenly onto the planer bed, thus insuring that the work be held flat without any hammering.



The Massey Divided Vise.

Two styles of this vise are being made. One, No. 60, being for large work and having jaws 3¼ inches deep. The other, No. 61, is for holding strips or work that is to be set true to the edge. The lower edges of the jaws of this vise are only three-eighths inch from the bed of the planer.

MACHINERY.

April, 1903.

AMONG THE SHOPS.

NOTES ON ELECTRIC WELDING—NEW SHOPS OF THE STANDARD ROLLER BEARING CO., PHILADELPHIA—MISCELLANEOUS DATA.

AMONG the applications of electricity to useful purposes, that of electric welding is probably less appreciated or understood than any other important use to which it is adapted in the arts. We believe that even the recent developments in electro-chemistry that have come about since the establishment of the first Niagara Falls power plant are more widely known than are the possibilities of electric welding. The process is used, however, by many large manufacturers, especially in the lines of carriage hardware, wire and wire goods, and bicycle and automobile parts; and for miscellaneous work of almost endless variety, such as welding street railway rails, lengths of piping, chains, printers' chases, carpenters' squares, the teeth of large saws, axe heads, etc.

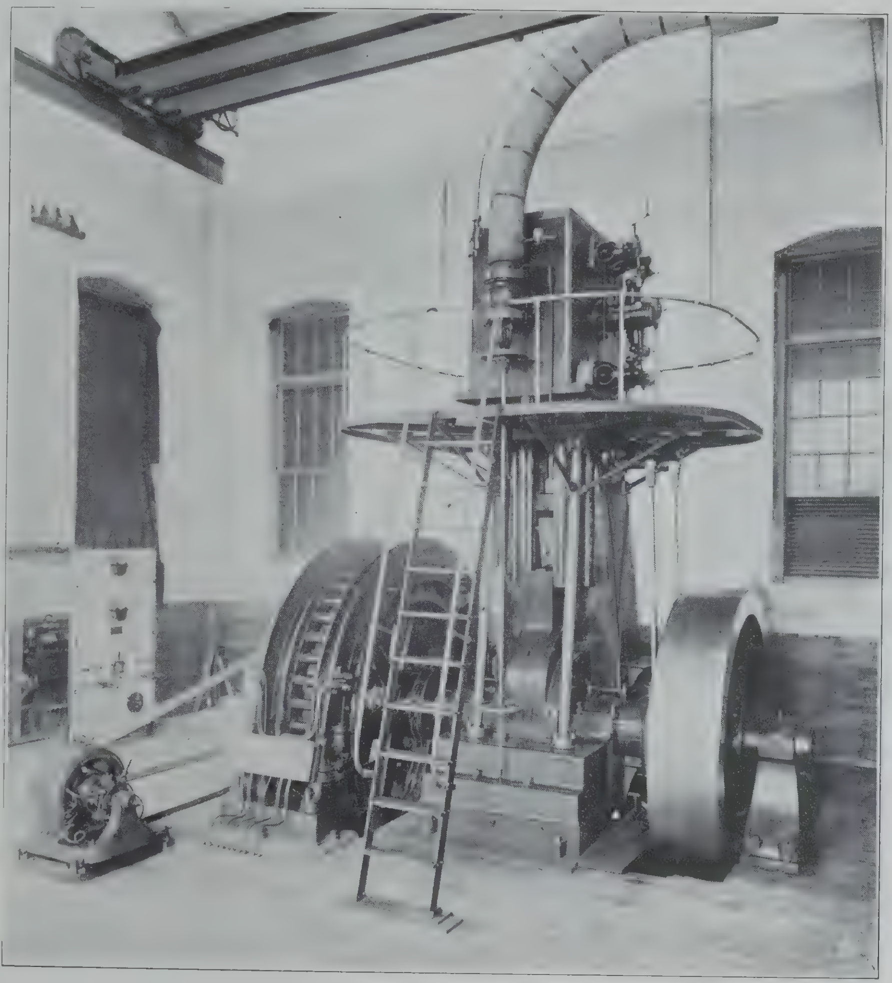


Fig. 1. Engine Room of Standard Welding Co., Cleveland, O. Five hundred H. P. Engine and Generator used for Supplying Current to Electric Welding Machines.

It is also probable that of the various plants using electric welding processes, that of the Standard Welding Co., Cleveland, O., is of the greatest interest, because of the variety of welding that is accomplished there. The first time that the writer called at these works it was a matter of surprise to him to find a power plant of such proportions as it required for supplying the current for the welding operations. A view of the engine room is shown on this page. It is equipped with a modern vertical engine of 500 horse power, direct-connected to a General Electric 350 K. W. generator with revolving fields, especially designed for electric welding purposes. The engine has Corliss valves, with shaft governor, and the generator supplies a two-phase current, operating at 350 volts with 500 amperes per phase. The whole power of this generating unit is required for supplying the current to the different welding machines in the works, which indicates the extent to which this new branch of the metal-working industry has been developed in this one plant alone.

The Standard Welding Co. is unique in that its entire business consists in electric welding and nothing else; or at least in manufacturing articles in which electric welding is an integral part of the process, without which the products would have to be manufactured in an entirely different way and in most cases at a greatly increased cost. In connection with products that are regularly manufactured and sold is a well-equipped jobbing department where work of all descriptions within the capacity of their machines is welded for the trade. Here various kinds of articles which it is practically impossible to weld by the forge method, are electrically welded. But no work is solicited for this department which can be economically welded by ordinary methods, since electric welding has its own distinctive field of usefulness in making it possible to produce certain articles by an entirely different course of procedure from what would ordinarily be followed. This is practically a new field, which as yet has not been adequately explored, and many manufacturers of all kinds of machinery could undoubtedly adopt the method of making different parts or sections of pieces separately and then finishing by welding, producing a superior article at greatly reduced cost. This method also permits using complicated machine parts, if desired, without entailing a high cost of production. One feature is the possibility of reducing the cost of screw machine work or of eliminating some of it altogether.

This can be accomplished where a large amount of metal would ordinarily be removed from the bar, producing a shank of much smaller diameter than the other parts of the piece. By using stock of small diameter for the shank and welding it to the larger piece, after both have been finished, the completed product may be obtained equal in every way to that produced entirely on the screw machine. By means of a swaging machine taper stock can be produced and welded to a straight body; tool steel can be welded to machine steel or iron; and where lightness or strength is desirable a piece built up partly of tubing and partly of solid stock—as where a link or stay is required—having solid eye ends.

The chief product manufactured by the Standard Welding Co. is tubing, made from cold-rolled open-hearth steel, which is rolled into cylindrical form and electrically welded and finished by drawing, swaging, and polishing in the usual manner in which all tubes manufactured by the hot piercing and rolling process are finished. Reducing the diameter of

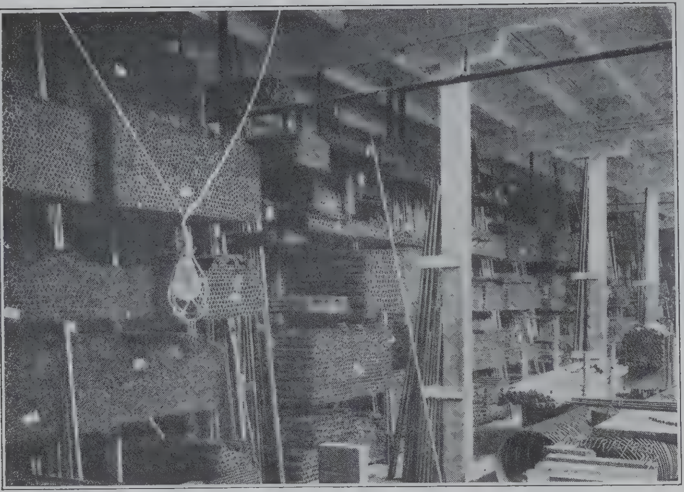


Fig. 2. View of Stock Room showing Stock of Tubing.

the tubing on the draw bench makes a severe test of the joint at the seam, which, however, is known by many laboratory tests to be as strong as the rest of the metal. In fact, one of the products turned out with success is tubular steel bottles in sizes up to and including five inches diameter, which are intended for the storage of compressed gases and are regularly tested at 4,000 pounds per square inch. These are made by welding the caps and bottoms to sections of open-hearth tubes made by the electric welding process. The extent of the tubing branch of the business can be judged by the stock of tubes shown in the illustration, which is from a photograph of the stock room.

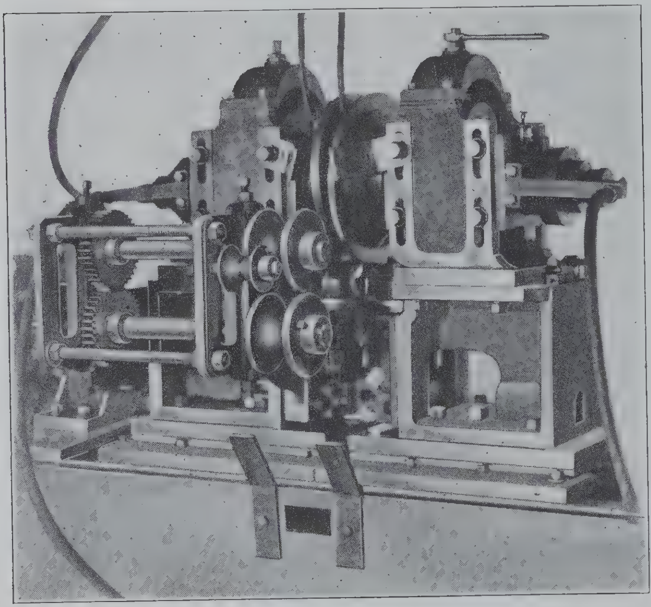


Fig. 4. Machine for Welding the Longitudinal Seam in Tubing.

The next most important item of manufacture is that of rims for automobiles and carriages—principally the former—these being made in standard sizes and shapes, gaged accurately to dimensions, so that the wheels to which they are to be applied may also be made up in standard sizes and both wheels and rims be interchangeable.

Still another important feature is the manufacture of bent parts from the tubing which they make, for use by bicycle manufacturers, such as rear forks and stays, fork sides, fork stems and seat posts, together with bent tubes for frames for ladies' bicycles.

Electric welding is carried on under the patents of Elihu Thomson, which are controlled in this country by the Thomson Electric Welding Co., Lynn, Mass. The principle involved in electric welding is that of passing currents of electricity through the abutting ends of pieces of metal to be joined, thereby generating heat at the point of contact, while at the same time pressure is applied to force the parts together. As the current brings the metal to the welding temperature and the surfaces to be united become soft the end pressure causes the opposing points of these surfaces to come into intimate contact and form a perfect weld.

Nearly all machinery for electric welding is of special design, to adapt it to the various classes of work. A welding machine consists primarily of a transformer, by which alternating currents of comparatively high pressure and small flow may be changed to currents of very low pressure and great volume, mounted in a suitable frame bolted to two gun-metal or copper tables on which the clamps for holding the pieces to be welded are placed. The current from the transformer enters the piece to be welded by the holding clamp, and passes through the joint between the pieces, heating the metal at the joint and a small distance on each side of it. The operation of welding is performed very quickly, the time required depending upon the power applied and the cross-sectional area of the metal to be joined. For very small work, up to ¼-inch in diameter, semi-automatic welding machines are used, on which as many as 8,000 welds have been made in a day of ten hours. In some work of larger size, requiring care in adjusting the pieces, the speed may be as low as 200 or 300 welds in the same time. Two horse power applied to the dynamo is sufficient to weld a piece ¼-inch in diameter in 2 seconds; a piece ¾ inch in diameter can be welded in 18 seconds, with about 13 horse power. It is found that about 28 horse power is required to weld one square inch area of iron or steel in 45 seconds. To weld a piece of twice this area, twice the horse power would theoretically be required, although practically a little more than double the power would be necessary. A piece 4 square inches in area requires 84 H. P., to be welded in 90 seconds.

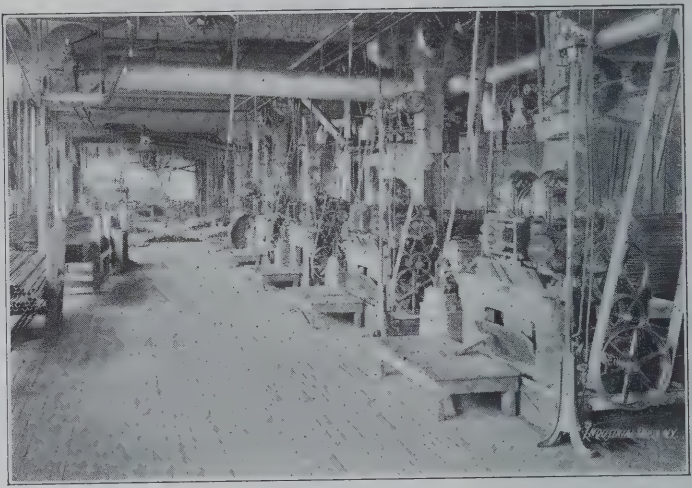


Fig. 3. Row of Electric Welding Machines in Tubing Department.

In heating pieces to be welded in a forge the outer surfaces become hotter than the interior, inasmuch as the heat has to travel from the outside toward the inner sections, and there is more or less scaling and sometimes blistering. To

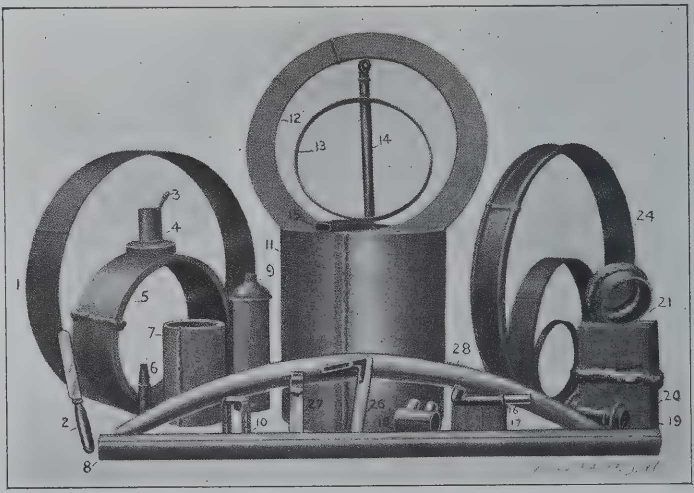


Fig. 5. Group of Electrically-welded Pieces. See List on Next Page.

offset this some flux is employed, particularly in the case of steel, which is difficult to weld by the ordinary method. The heat also travels along the piece, often injuring parts of metal not required for the welding. In electric welding there is absolute control over the heat, the process can be continually watched and there is no formation of scale, tending to produce an imperfect weld. The heat effect is from the center toward the outside of the piece, and when the weld is made the structure of the metal at the joint is the same as elsewhere. A great advantage also is the fact that various kinds of metals, such as copper, can be welded; or two different kinds of metals may be joined where heretofore the welding could be produced only by the greatly inferior process of brazing.

The tubing manufactured by the Standard Welding Co. is made from flat sheets of steel, formed into the shape of a cylinder by passing between pairs of grooved rolls, the axes of these being alternately in vertical and horizontal planes, so located as to draw the edges of the steel together to form the tube. In Fig. 3 is a view of the section of the tubing department, showing a row of electric welding machines designed especially for this class of work. Fig. 4 gives a front view of one of these machines. In this the tubing, previously rolled into cylindrical form, is fed to the machine and the edges pressed together by the grooved rollers. Then the edges of the tube come in contact with the peripheries of two rotating discs which serve as contact points by which the current is made to pass through the section to be welded.

Fig. 5 is a reproduction of a photograph from a collection of pieces of various descriptions turned out in the different departments, and illustrating the variety of uses to which electric welding can be applied. A list explaining Fig. 5 is given herewith:

1. Cylindrical band 6 inches wide by ¼ inch thick.
2. Knife handle (steel).
3. Crucible steel end welded to machinery steel.
4. Gear case housing—steel tube welded to stamping.
5. Iron ring for magnetic field circuit for motor vehicles.
6. Taper plug for handle bar—stem welded to straight tube.
7. Cream separator bowl.
8. Electrically welded tubing 2 inches O. D. by 13 gauge.
9. Nitrous oxide gas bottle, tested to 4,000 pounds.
10. Continuous band, bicycle pedal.
11. Cylinder for soda water tanks, tested to 600 pounds.
12. Disk 3 inches by ¼ inch for automobile flanges.
13. Baby carriage tire.
14. Kelly handle bar forging, welded to steel tube.
15. Oval tube, 13 gauge.
16. Bicycle seat post forging with welded extension.
17. Retaining band, 7 inches by .090 inch for soda water cylinders.
18. Bicycle bottom bracket.
19. Pressed steel automobile hub.
20. Section of Bessemer steel, welded, 6 inches by 2 inches.
21. 4-inch steel tube by ¼ inch walls.
24. Standard clincher rim, Goodrich type.
26. Bicycle seat post.
27. Part of butcher's saw frame.
28. Tubular arch for Baker motor vehicle, made from tubing.

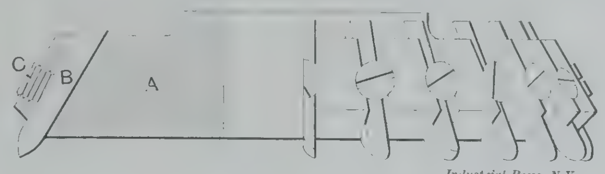
NOTES FROM THE GARVIN MACHINE CO., NEW YORK.

A form of inserted-tooth milling cutter is quite generally used in the extensive machine shops of the Garvin Machine Co., New York, which, we believe, is rarely met with in other shops. The feature that distinguishes this cutter from others is the manner of recessing for the cutters and the location and form of the binding screws. The principle of construction is shown in Fig. 1, which is not drawn to scale but only given to illustrate the idea.

The cutter body is turned on the edge to the approximate shape shown, the longer or upper side being at an angle of, say, 30 degrees with the axis of the work spindle. The slots for the cutters are milled at the same angle, but before this is done the holes for the binding screws are drilled and tapped and then the slots are milled directly through the center of the holes, leaving an equal amount of thread on each side. The screws are necessarily short and of comparatively large diameter for the size of steel in the cutters. These features, together with that of the interrupted thread, might be thought to render the fastening somewhat insecure, but it apparently works well in practice.

A sort of universal jig attachment is provided for almost all the upright drills in this shop, which is of a simple character but one, nevertheless, that has been found most useful on many classes of work that must be drilled to a certain degree of interchangeability, and for which regular jigs would be too expensive. It consists of an angle piece, *A*, Fig. 2, clamped to the vertical column of the drill so as to be adjustable vertically. The outer end is bored concentric with the drill spindle on the drill itself, for a guide bushing *C*. A series of guide bushings are, of course, supplied for all sizes of drills used, the same as with the regular jigs. On the under side of the angle piece is planed a shallow groove lengthways of the horizontal arm, and in this is fitted the tongue of a Y-shaped piece *D*. This piece is slotted for a clamping screw, as shown in the plan view in the upper part of the cut, Fig. 2.

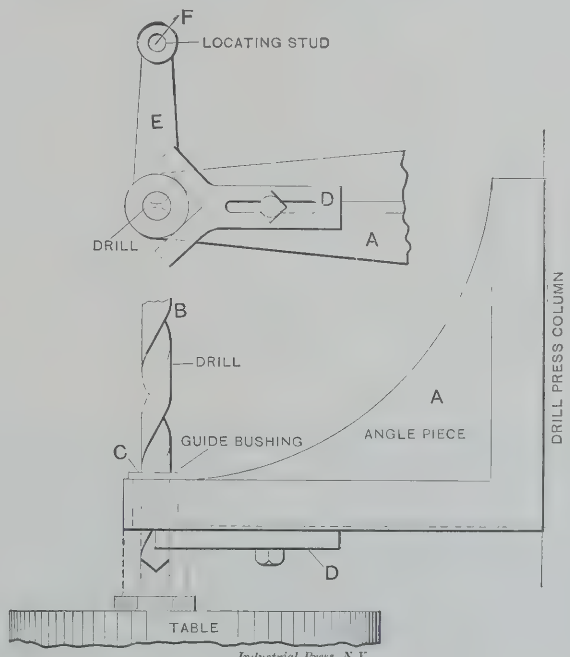
The idea of this jig is to provide means by which round bosses such as the ends of levers, connecting-rods, bell-cranks and similar parts that are a large part of the work on certain classes of machinery, like paper bag machines, etc., can be automatically centered without the use of a special jig for each piece. The device is also used to get the holes at exact distances apart, as also shown in the plan in Fig. 2. After the hole in one end of a lot of levers has been drilled, a stud, *F*, is located on the drill-press table, which closely fits the holes. This stud is so located as to permit the other end of the lever that is to be drilled to swing into the angle of the Y-shaped piece and center under the drill. It will be understood that the operation of setting a piece to be drilled in this manner is much quicker than the telling of it.



Industrial Press, N.Y.

Fig. 1.

An interesting machine in this shop is a special tool designed by Mr. Norton for boring the holes for the spindle, overhanging arm and back gears in the frames of milling machines, also drilling the holes for the binder screws for the overhanging arm and sawing the slots—all at one setting.



Industrial Press, N.Y.

Fig. 2.

The machine has a complete and expensive equipment of boring bars, cutters, etc., for all the sizes and styles of column milling machines built by the company. The three holes for the spindle, overhanging arm and back gears are all bored at the same time. The drilling of the binder holes and sawing of the slots so that the metal may be gripped onto the overhanging arm, are done afterward.

In making cone belt pulleys, it is the practice to first bore them in a Beaman & Smith double-head machine, boring from each end at the same time with boring bars carrying one cutter each. A recess is, of course, cored in the middle, so that clearance is given between the two bars, that a hole

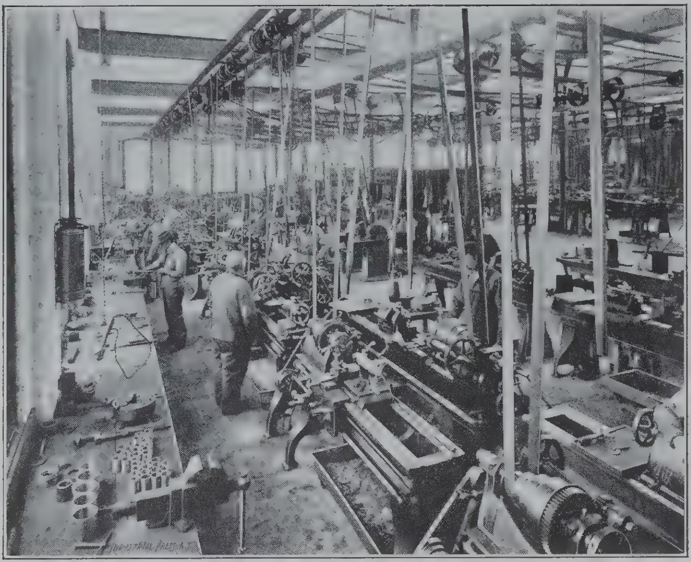


Fig. 1. General View in New Machine Shop of Standard Roller Bearing Co.

may be finished without interference. The cone pulley casting is held between the two heads of the machine in a simple frame or jig which is adjustable so as to be universal for the different sizes of cones. The same machine, with other jigs, is used for many other operations of equally novel character.

The Garvin shop being in a large city is naturally built in a vertical direction rather than being extended over a large area. The building is eight stories high, besides the basement, making nine floors in all. Of course elevators are provided, which make the trip from one floor to the other quick and easy; still it is scarcely expedient to use them for transporting tools from the tool room to the different floors, so auxiliary tool rooms are provided which carry a small stock of the tools most called for in each department, and the others are requisitioned from the main tool room by means of a chain conveyor. The order is carried down to the main tool room and the required tool brought back in the same manner. The conveyor runs constantly in one direction, the flights or buckets being so constructed as to always remain right side up while making the circuit.

The drawing room is a well-lighted room with 11 drawing tables. These tables are so constructed that a draftsman can work on any side without interference with the table support. The support is a cast-iron column screwed to the floor, and the table is secured to the top of the column in a horizontal position, the arrangement being non-adjustable. Over 4,000 drawings are filed in cases in the drawing room, and all originals are also preserved. The card index is used for reference.

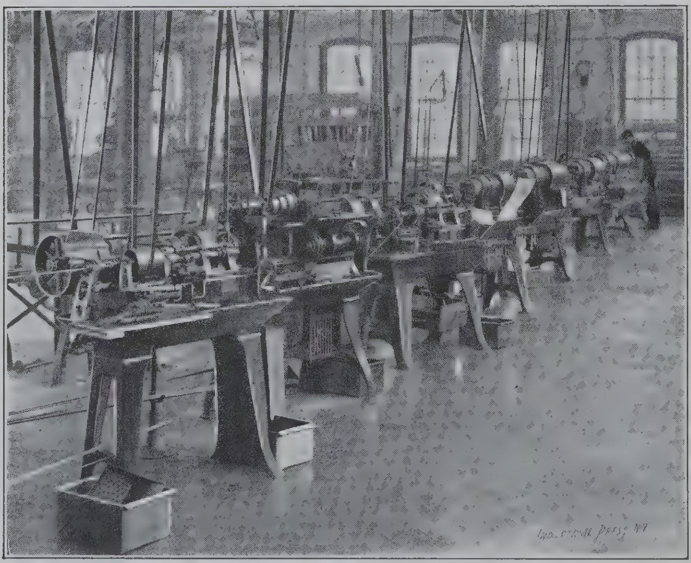


Fig. 3. Row of Screw Machines making Rollers and other Small Parts of Bearings.

NEW SHOPS OF THE STANDARD ROLLER BEARING CO., PHILADELPHIA.

The Standard Roller Bearing Company, Philadelphia, are now located in their new factory, which is situated upon a tract of three acres facing upon the main line of the Pennsylvania Railroad, about 10 minutes' ride from City Hall. The buildings consist of a three-story brick building 60 by 200 feet, an office building 25 by 75 feet, main shop 150 by 200 feet, with boiler house engine room and blacksmith and forging shops built adjoining the main shop, but separated by fire walls. All buildings are of brick and steel construction and the roof of the main machine shop is of the saw-tooth variety, facing north, which gives a strong light throughout the shop. A record was established in building the main shop. In 47 days from the breaking of ground the entire building was finished, complete in all respects, and in four months from the breaking of ground the machinery had been moved from the old factory in the center of the city and was set up and running to full capacity in the new factory without interfering with shipments to any extent. A brass foundry is now nearly finished and an addition to the main shop 125 by 320 feet will be erected during the coming summer.

The Departments.

At one end of the machine shop are the drafting room, pattern room and stock room, and adjoining the latter, the shipping department. At the other end of the building, a side-track runs into the property adjoining the main machine shop and is formed into a steel storage room. All of the steel used is brought in at this point, the machines being set in such a manner that the steel is gradually worked from one department to the other, until at the other end of the building it comes out as finished stock.

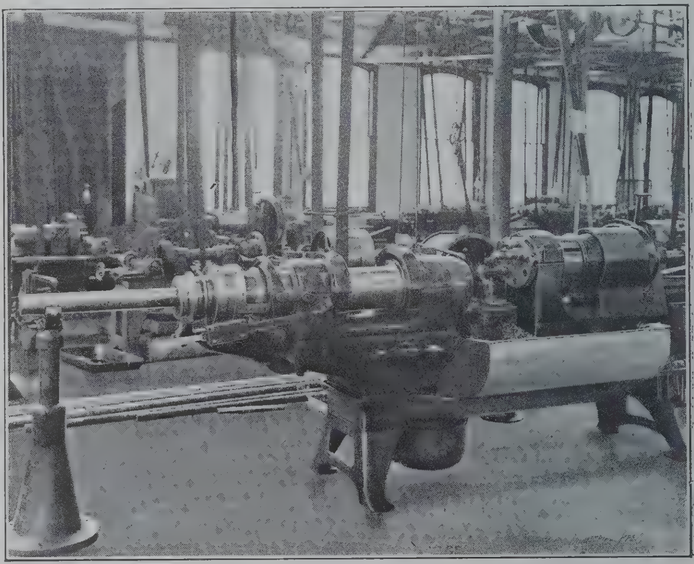


Fig. 2. The Largest Automatic Screw Machine ever built; Operates on a 6-inch Bar.

In the center of the building is located the tool room, being a small room separated by wire netting from the balance of the shop. After the tools are made, they are placed in another separate room, from which tools are taken as they are required by the machinists, who leave the usual check for each tool as they receive it. On Saturday of each week, all tools are returned and checked off and delivered again to each workman on the following Monday.

On one side of the shop, and in a department by itself, are lathes in two lines. This department turns out the special sizes of bearings which cannot be made to advantage on automatic machines. Adjoining this, is the milling machine department, and in another separate department are two rows of Cleveland automatic machines, and two rows of hand screw machines. At the other end of the building, also in a separate department, are the drilling and special machines used for making roller bearing and ball bearing cages, thrust cages, etc. Adjoining this is the grinding department, consisting of a number of external grinders, with water attachment; and about sixty universal grinders, each of the latter being connected with an exhaust fan, which draws all emery dust through pipes, carrying it to a tank upon the roof, the result being that this department is as clean and free from dust as the lathe or any other department.

In the power plant is a Berry Boiler and a C. H. Brown engine, which, by the way, is an exceptionally quiet-running engine. A Crocker-Wheeler generator produces electricity for lighting and other purposes, and also for power in the three-story building above referred to, which is used for assembling, storage, etc. The engine is connected by ordinary belt drive, with three main lines of shaft, all the latter being equipped with Standard roller bearings. The main drive connections are made in the center of the building, each being connected with a friction clutch made by the Medart Patent Pulley Co., the result being that any one of the six departments may be run separately if desired.

The principal product consists of grooved ball thrust bearings, roller thrust bearings, ball thrust collar bearings and roller journal bearings. The rollers for the bearings are ground to gage after being hardened. With the journal roller bearings are furnished hardened steel sleeves or bushings, one to be forced on the shaft and the other to be forced into the box or housing over the rollers, so that the rollers have hardened steel to run upon. The bushings are ground accurately inside and out, so that they are perfectly parallel. This work is done on universal grinding machines.

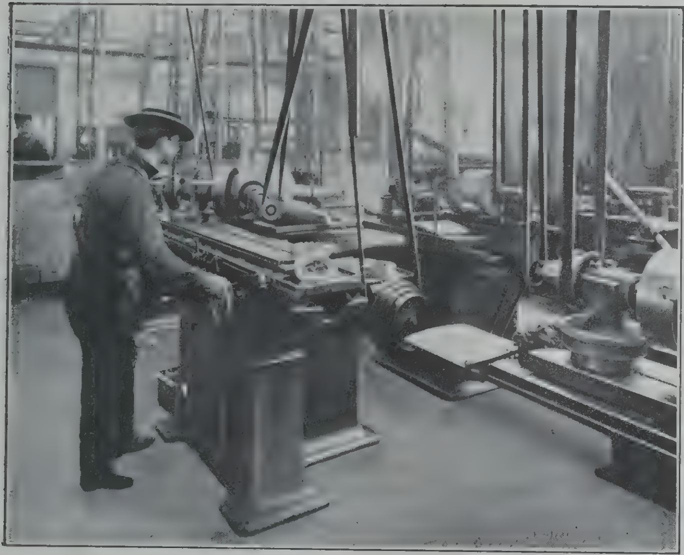


Fig. 5. Grinding Rings for Grooved Ball Thrust Bearing.

With both ball and roller thrust bearings, hardened steel washers are furnished, ground accurately upon both sides, after being carefully hardened. Tool steel is rarely used in bearings, owing to the fact that it breaks or chips very easily and does not give as good results as case-hardened steel. The steel washers, sleeves, etc., are case-hardened to a depth of from 1-64 inch to ½ inch, according to the weight, etc., to be placed upon the bearing, the depth usually being about one-third the thickness of the piece, leaving the center third soft. The hardening is done by placing the steel in cast iron boxes, in a preparation of bone, and baking it from eight hours to forty-eight hours, according to the depth desired. Steel treated in this manner has great toughness, owing to the fact that the center is soft while the outside gives a glass hard wearing surface, and is in effect, tool steel on the outside and machinery steel inside. Case-hardened pieces can be bent to a considerable degree without cracking, while the outside surface is so hard that a file cannot cut it. Any depth of hardening that may be required can be readily furnished after sufficient experience, and it is probable that case-hardened steel will be more generally used as its merits become better understood. A fracture of case-hardened steel shows a very fine grain, similar to tool steel on the edge, the center being of a larger grain and similar to ordinary machine steel. The case-hardening department consists of six furnaces, having a capacity of about 4,000 pounds per day. Fuel oil is used exclusively in these furnaces, as it gives a very uniform heat, and one easily controlled. The furnaces were designed by the Standard Roller Bearing Company, but are very similar to the Brown & Sharpe type. In addition to the case-hardening furnaces are three coal forges, drop hammer, and the necessary water and oil tanks for tempering.

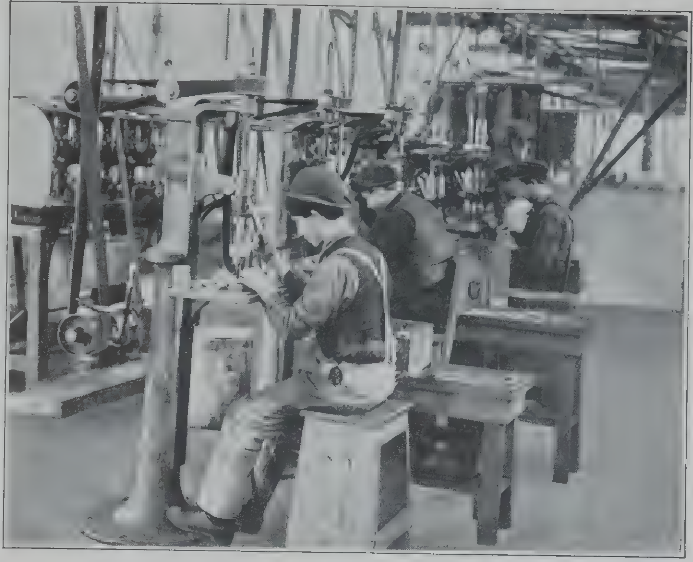


Fig. 4. Row of Drills.

A number of special machines are in use, designed for the manufacture of roller bearings. One of these is a six-inch automatic screw machine which will work up a six-inch bar, weighing 3,500 pounds, entirely automatically. It is used in making ball thrust collars and rings. It is powerfully geared, with two forward speeds and several cone changes on the countershaft. There are six holes in the turret and a section of the bar 6¾ inches long can be operated on at one setting. This machine was built especially for this work by the Cleveland Automatic Machine Co., Cleveland, O., and so far as we are informed is the largest automatic screw machine ever constructed.

A special machine was designed for drilling roller thrust cages, as is shown in the illustration. This machine works automatically, drilling to a certain depth, when the turret moves backward, turning at the same time to the next point to drill, continuing the operation until ten, twelve, sixteen or more holes are drilled in the thrust cage. This machine is fitted for drilling either steel or brass, having a pump attachment to force oil when drilling steel.

A Rogers & Hurlbut cutting-off machine has been fitted up with a special pump for forcing oil upon the cutting-off tool. This has been done at a very slight expense, and has resulted in an increase in the output of the machine of from 30 to 40 per cent. at an increase of not over $25.00, in addition to which it keeps the tools in excellent condition.

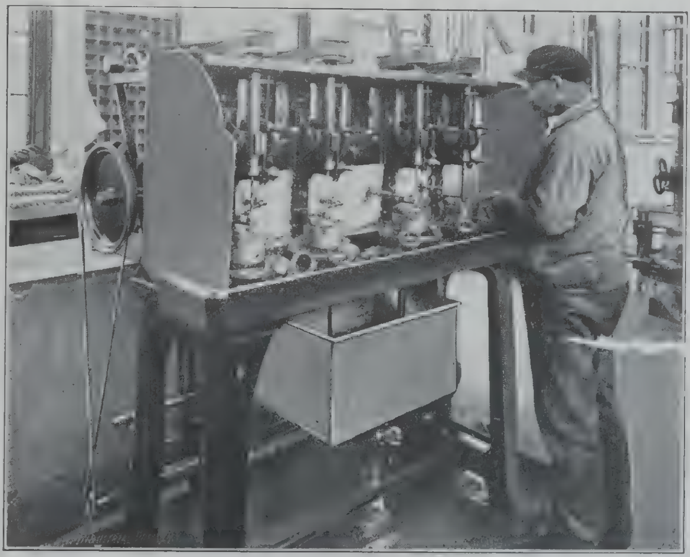


Fig. 6. Special Machine for Drilling Cage Ends.

An interesting testing machine has been made to give a graphic illustration of the utility of bearings, especially under heavy pressures. This machine contains a thrust bearing, the rings of which have an outside diameter of 8 inches and an inside diameter of 4 inches. It is arranged so that by compressing a spring a pressure of any amount up to the capacity of the machine can be brought against the bearing. Under 5,000 pounds' total pressure the bearing can be turned easily by hand by means of a small handle attached to one of the rings. With rollers removed it would not be possible, of course, to move the disks at all.

The use of roller bearings has grown materially during the past few years. At our request a list has been prepared of the different uses to which bearings sold by this firm have been put, and opposite each name is given the number of firms using these bearings for the different purposes enumerated. Some bearings have been made of unusual dimensions, for very heavy duty. The Russian government has had several, to be used in a testing machine on a 10-inch shaft. These bearings are 14 inches long with 1¼-inch rollers and carry 400,000 pounds each, at 200 R. P. M. The United States government has recently tested a roller thrust bearing successfully under 80,000 pounds pressure and at 300 R. P. M. The outside diameter of this bearing was 22 inches. For very heavy work roller bearings are preferred to ball bearings. It has generally been assumed that roller thrust bearings should be designed with taper rollers or cones, so that a roller will be in perfect rolling contact at every point and operate without slipping. This company, however, have had good success with a thrust bearing having a disk or cage containing a large number of very short rollers arranged with their axes radial. While theoretically there would be a small amount of slip, practically with so short rollers this is negligible, and this type is recommended for nearly all purposes where a heavy thrust is to be taken. The most interesting application of these is for marine work in place of the usual horse-shoe thrust bearing almost universally used on steamships and yachts. Roller bearings of this construction need no water jackets and but little oil. In one instance the saving of oil—which is a considerable factor—was reported as 85 per cent. Propeller shafts for vessels up to 5,000 tons displacement have been fitted with these bearings, with the result of an average increase in the speed of ¾ knot per hour. In one case the saving of 1¼ knot per hour was reported by the captain of the vessel. It is estimated that if an ocean liner should have as great an increase in speed through the application of roller thrust bearings as the smaller vessels have shown, the trip from New York to Southampton could be made in one-half day's less time than at present.

List showing the Varied Uses to which Bearings made by the Standard Roller Bearing Company have been put and the Number of Firms using them.

Engines	5	Windmills	2	Horizontal Shafts	1
Drills	16	Fans	5	Boring	2
Launches	7	Armoring Machines	1	Milling Machines	1
Elevators	12	Cotton Baling Machinery	1	Dampers	1
Bolt and Nut Machinery	2	Broaching Machines	1	Planers	4
Valves	3	Tapping Machines	1	Riveters	1
Motors	4	Coating Machines	1	Hoe Carts	1
Pumps	5	Heel Finishing Machines	1	Die Cutters	1
Schooner Yachts	1	Axle Machines	1	Slotters	2
Rubber Machinery	1	Griffin Mills	1	Special Machines	6
Turn Tables	2	Tubing Machines	4	Wood Working Machinery	5
Automobiles	21	Grinding Machines	6	Electric Striking Machines	1
Steering Apparatus	4	High Speed Machinery	1	Water Wheels	4
Cranes	25	Power Saws	1	Transmission Gears	1
Hacking Screws	2	Steel Roll Mangle Machines	1	Combing Machines	1
Saw Mill Log Carriages	1	Disk Harrows	1	Street Wagons	1
Vertical Shafts	7	Revolving Lights	1	Electric Motor Signals	1
Punching & Shearing	1	Agricultural Implements	1	Hoists	2
Experimental	7	Feed Mills	1	Distillery Presses	1
Pumps	1	Flying Horses	2	Shafting Machinery	1
Misc. End Thrusts	14	Corn Huskers and Shredders	1	Mash Machines	1
Engine Governors	5	Boring and Turning	1	Barrows	1
Lathes	7	Well Drill Machines	1	Road Scrapers	1
Electric Tools	1	Light Running Special Machinery	2	Lamp Wick Machinery	1
Shingle Machinery	1	Tumbling Barrels	1	Cutters	1
Doors (Safe)	1	Drill Presses	3	Tool Slides	1
Trucks	8	Pulley Turning and Boring	1	Tubular Wheels	1
Shapers	5	Knitting Machines	1	Steel Bending Machines	1
Bottle Washing Machinery	1	Friction Hoists	1		

The standard type of cylindrical bearing adopted carries rollers in a cage in the usual manner, but each end of each roller is rounded and bears against a steel ball which is perfectly free to turn, but is retained in place by the construction of the cage. It has been found that without these steel balls there is so much friction at the ends of the rollers, whenever there is any tendency toward an end thrust of the shaft, that the rollers and cage become twisted and do not remain in axial alignment with the shaft. It is evident that in some cases the rollers in rotating would bear against one end of the cage and tend to retard the rotation of that end; while the cage containing the free ends of the rollers would tend to forge ahead, producing the twisting action referred to. It has been found that the insertion of a ball at each end of each roller prevents this. The balls constantly present new surfaces for the rollers to bear against, and as they are very smooth and hard they make excellent thrust bearings for the rollers. An additional advantage of this construction is that the balls prevent the cage from wearing out.

* * *

POWER REQUIRED FOR LATHES USING HIGH-SPEED TOOLS.

It has been quite fully demonstrated, we think, that machine tools of the older types now in general use, especially lathes, are not capable of giving the maximum output possible with the high-speed steels that are now so rapidly coming into general use. Being designed for surface speeds of something like 25 or 30 feet per minute, they have not the strength and rigidity that must accompany a tool cutting at a surface speed of, say, 60, 80 or perhaps more than 100 feet per minute. If the power required increased in direct proportion to the speed, the conditions would not be quite so severe on the older machines, but it does not. In a lecture delivered before the Keighley Technical Institute, Mr. John Miley said that the power required for a surface speed of 80 feet per minute—cut being 3-16 inch deep and feed 1-16 inch—was about 8 times that required with the same feed and cut at 20 feet per minute. He mentioned a test made with a 24-inch lathe driven by a 10 horse power motor. This motor was found of insufficient power and a 26 horse power motor was substituted instead. The belt cone was driven at 1,000 turns per minute and at this speed it took no less than 6½ horse power to drive the lathe, with the work between the centers, and the feed gear operating the saddle, but without the tool touching the work. It absorbed 13 horse power to do this work—that is to say, it took 6½ horse power to drive the lathe empty at that speed, and 6½ horse power to remove this weight of cuttings, 5 pounds per minute. When the cut was increased to ⅜ inch deep instead of ¼ inch, it removed 7 pounds per minute, but required 20 horse power to drive it; thus 7 horse power extra was absorbed in removing an extra 2 pounds of cuttings per minute. From this it is evident that the power goes up more than in direct proportion to the weight of the cuttings removed.

* * *

A bridge has been erected on the line of the Pacific Railway in Costa Rica to span the Rio Grande River. It is higher than any bridge in the United States, being 340 feet from the tops of the rails to the bed of the stream. The length of the structure is 685 feet and its total weight is 932.5 tons.

SHOP CONSTRUCTION.—7.

LIGHTING–ARRANGEMENT OF WINDOWS AND LAMPS.

OSCAR E. PERRIGO.

The heating and ventilation of our manufacturing buildings having been duly provided for in the last article, the next question of importance to be considered is that of lighting, which forms the subject of the present article.

In considering the matter of lighting manufacturing buildings we may properly divide the subject into two parts. The first of these relates to the utilization and management of the sunlight for our use during the daytime; and the second, to the artificial light which we must provide in the absence of sunlight and in the dark and obscure corners, of which there should be as few as possible in the modern shop.

For properly lighting a shop during the daytime, many forms and proportions of windows have been devised, from those of small area and diminutive lights of glass, to those very high and narrow; those broad and low; those of large area placed far apart; those of much less area placed near together; those covering almost the entire wall with glass area; those placed vertical and those in an inclined position; those placed as skylights in the roof; and those placed in the ventilating space at the top, or ridge of the roof. Again, as to the kind and quality of glass used. Some prefer the ordinary plain glass, admitting a flood of light, regulating it by means of shades or curtains. Others use the same glass, "stippling" the surface with white lead paint to relieve the eyes of the glaring light. Again, ground glass is used. Still others prefer the rough cast or "cathedral" glass, as it is sometimes called. One inventor proposes to construct windows composed of a series of round rods of glass placed closely together, and states that one of its advantages is that if broken by a flying chip, or in any similar manner, only one or at most a few of the rods will be injured, and these may be easily and cheaply replaced.

In reviewing these various methods of construction it may be said that broad and low windows in the side walls will light the bench at the wall and perhaps one or two rows of machines, while the center of the room receives little or no illumination. This condition is sometimes sought to be remedied by the use of skylights in the roof. Windows placed too high in the side walls will light the center of the room but leave the benches around the walls in the shadows of the high window sills. Therefore it is proper to so locate the window sill as to afford proper light at the bench vises; then to continue the window well up to the ceiling in order that the whole room may receive, as nearly as may be, an equal quantity of light. The width of the windows and their distance apart is a matter of great difference of opinion. Where the construction is of steel or wood they may be placed less than two feet apart, if it seems necessary to do this. Where brick walls are used the distance should generally be more, depending, of course, on the entire height of the wall. In our arrangement of the windows in the machine shop (as given in our article in the November, 1902, number), the size is, four feet wide and ten feet high. These figures are the dimensions of the inside of the sashes, therefore providing forty square feet of glass. This will make the opening in the wall nearly five feet wide, which, with bays of eighteen feet three inches centers—two windows to each bay—will give about four feet two inches of brickwork between the windows. This will give sufficient strength to the side walls, and will also provide quite enough light for all ordinary classes of machine shop work to be done in such a building.

Skylights should not be used where they can be avoided, as they are a prolific source of leaky roofs, damage by accidental breakage, as well as numerous other difficulties, and even a light fall of snow quite destroys their lighting properties. Windows in the ventilating portion of the roof are not only useful for lighting the central portion of the shop, but they conveniently act as ventilators when the sashes are hung on pivots and handled by cords. They may easily be so constructed as to avoid any trouble from leaking.

As to the kind of glass to be used the plain glass is, of course, the cheapest. It must, however, be shaded by curtains, which can be readily run up and down; and these are liable to get out of order and to require a continual expense to keep them in presentable and useful condition. The amount thus spent added to the cost of plain glass will soon pay for good ground glass which will need no curtains, and which, while rendering the light soft and agreeable to the eyes of the workmen, will also diffuse it over the area of the shop much better and more equally than the plain glass. At the same time none of the light is lost by interposed shades or curtains. As to "stippled" glass, the stipple is apt to crack and peal off, and will also absorb considerable dirt and grease, making it much more difficult to keep clean than clear or ground glass; and the repeated washings are apt to remove portions of the "stippling," leaving a patched and unsightly effect. The rough or "cathedral" glass is more expensive, not as agreeable to the eyes, and considerably lessens the volume of light. Windows of glass rods do not seem to have been sufficiently employed to demonstrate their usefulness.

We have seen shops in which practically the whole side wall was a mass of glass, only the space for the posts supporting the roof and the frames containing the sashes being opaque. Such a prodigality of light does not seem necessary in practice, and in fact it may be hurtful to the eyesight of the workmen, while the cost of construction and the continual cost of renewals and repairs of such a great quantity of glass will be a large initial expense as well as an important annual outlay.

Let us now consider the question of artificial light. First, the usual time during which we must provide for artificially lighting up the buildings. Omitting the six usual holidays of the year and calculating on the basis of a ten-hour day, we have 3,060 working hours in a year's work. If the working day begins at 7 A. M. and ends at 6 P. M., with one hour for dinner, we shall need artificial light, for the ordinarily well lighted shops, for about 460 hours out of the entire 3,060 working hours of the year. This will include "lighting-up time" divided among the different months as follows: January, 102 hours; February, 60 hours; March, 32 hours; May, 8 hours; June and July, none; August, 8 hours; September, 20 hours; October, 50 hours; November, 78 hours; and December, 102 hours. To properly provide for sufficient lighting during these periods we must select some one of the many systems in use, and the one which seems best adapted to the conditions of the case. Whatever may be the future development, either as to perfecting and simplifying its application, extending its sphere of usefulness, or reducing its cost, electricity at present stands at the head, when the question of a perfect light, or at least the most available one, is considered, for the illumination of nearly all classes of large buildings, particularly such as are used for manufacturing purposes. Still there seem to be indications that there may be yet other systems of artificial lighting which by development may become dangerous rivals of the popular systems of electric lighting—acetylene gas, for instance. This method is still in the infancy of its development and use, and there seem very few of the usual difficulties to be overcome excepting the danger of its explosion in the hands of inexperienced persons. This difficulty will probably be overcome in time and the use of it be as safe, both to generate and to manage, as electricity. It is also true that the system of electric lighting has many fatal accidents charged against it. These may all have been due to improperly-constructed apparatus, the careless management of it, or the imperfect knowledge of its properties and action. The same may be said of acetylene gas.

To provide an ample, proper, safe, and thorough system of illumination for buildings in which a large number of persons are obliged to labor for so many hours each year by its aid, would seem to be a matter that need not be argued or advocated. Yet there are many shops at the present time so constructed that some kind of an artificial light is needed all through the day, and in some at nearly all seasons of the year, and this condition prevails over a considerable part of the working space. The result must necessarily be that both the quantity and the quality of the work done is below the standard while the health and the eyesight of the employees are both unnecessarily impaired, since sunlight and fresh air are two very important elements necessary to the health, activity and usefulness of the human family. Ofttimes the evil results from a lack of consideration or appreciation of these necessities, and sometimes perhaps from a false idea of economy on the part of those having charge of such matters, which has led them to provide very indifferent substitutes for sunlight, or, in its absence, a proper artificial light. For it is true, "and pity 'tis, 'tis true," that in some shops, even in this enlightened age, many hours' work is done by the smoky glimmer of dirty oil lamps, these relics of a bygone age, since they are not many steps in advance of the vessels of oil with their fibrous wicks resting against one side, used in the days of Abraham, 1920 B. C. Although the common use of petroleum oils in various degrees of refining have revolutionized the old-time lamp, and the simplifying of the processes for generating and purifying illuminating gas have produced two very useful illuminants within the reach of nearly everyone, they will probably never regain the position which they lost when the practical utility of electric lighting became a recognized fact.

The one great drawback to all artificial means of illumination is that to produce light we must generate heat; and hence, however we produce light, whether by the combustion of oil or gas, or by the generation of an electric current, to form a brilliant arc, or a glowing incandescence, we must necessarily waste a large percentage of energy in producing heat which we do not want and which is often a very serious objection. We shall therefore not have the perfect light until we have been able to produce the illumination we desire without generating heat. Whether we shall ever realize that much-sought condition is a question for future development and invention to demonstrate.

In the application of the electric light in manufacturing operations we have the choice of the arc lamp and the incandescent lamp. Both have their objections as well as their merits. The arc lamp, being much more powerful and projecting its rays a much greater distance than the incandescent lamp, is well adapted to illuminating large areas, where there are comparatively few obstructions. In confined situations, or where there are many obstructions it produces disagreeable shadows, and its glaring brilliancy is hurtful to the eyesight of the workmen. Translucent globes or shades may be used, of course, but these devices necessarily reduce the illuminating power of the lamp. Again the arc lamp is not readily moved from place to place, even short distances, so that the workmen must often stand literally "in his own light."

The incandescent lamp gives a much softer and more agreeable light to the eyes of the workmen, who may work many hours by its aid with less discomfort than by almost any other light. It is also much more portable than the arc lamp, since it may be provided with flexible conducting cords of any convenient length, and hung up or held in the hand in the most desirable positions. Still another convenience of the incandescent lamp is that of being able to locate a permanent magnet in the base of it, by which means the lamp is retained in any desired position by simply placing it against any iron or steel surface. This is a matter of great convenience when working in dark corners or making repairs under machines, where the usual fixed lights are of little use and where ordinary incandescent lamps must be held in the hand; and also in awkward positions such as are frequently found during the work of erecting heavy machinery or repairing it. These convenient characteristics of the incandescent lamp render it valuable for practical use in the machine shop. It may be readily placed in confined situations where an arc light could not, and it may be used much nearer the eyes of the workman without injury.

It would therefore seem wise, in devising a system of artificial lighting, to avail ourselves of the advantages offered by both the arc and the incandescent lamps, each in the places where their special merits can be made use of. Both types of lamps may be operated by the current from one dynamo, by the use of proper transformers, but it will usually be found more practical to put in a dynamo specially designed for each system. Ample space has been provided in the engine room for dynamos for this purpose, as well as for furnishing the necessary current for operating the traveling crane in the machine shop and the power required in the foundry.

In the machine shop the clear space needed for the traveling crane precludes the suspending of arc lamps through this central portion, but they may be placed between and a little inside of the line of the columns. They should be about 50 feet apart, which would require 14 lamps on the main floor. In addition to these a sufficient number of incandescent lamps should be provided to accommodate the individual needs of the men operating machines, wherever such additional illumination is necessary from the location of the machines and the character of the work. They should also be provided at the small tool-distributing room and in the foremen's offices, and a number should also be hung upon the columns, having sufficient length of conductor cord attached to them so that they may be used in erecting machines in the central space.

From the character of the machines employed and the work done in the galleries the incandescent lamp will be the most suitable. There should be at least one to each machine and in the case of long lathes one to every ten or twelve feet of bed. A lamp should also be hung at the head of each stairway.

The large open space of the foundry may well be provided with arc lamps, four of which will be sufficient, supplemented by a few incandescent lamps with long cords hung on the columns, for use in deep molds and similar places left in darkness by the arc-light shadows. The chipping and pickling room will require one arc lamp and several incandescent lamps, all provided with wire nettings for protecting them from flying chips. The core room, wash room, foreman's office, water closets, the space under the cupola platform, etc., will require incandescent lamps.

The forge shop will be best served by two arc lights in the main part, and by incandescent lamps in the foreman's office, wash rooms, water closets and perhaps in the bar stock storage space. One arc lamp in the storehouse and one in the carpenter shop, with perhaps two or three incandescent lamps in the latter, will be sufficient.

The boiler room will require an arc lamp hung over the tram track so as to fully illuminate the boiler fronts, and two or three incandescent lamps convenient to the space in the rear of the boilers and in similar places. The same number and kind of lamps will answer for the engine room. The adjoining wash rooms and water closets should be provided with incandescent lamps, say four in each of the former and three in each of the latter.

An arc lamp erected on a pole 20 feet high should be located in the yard between the foundry and the power house and about 35 feet from the machine shop. A similar one should be placed in the center of the space between the storage sheds, carpenter shop, power house and the forge shop. These will greatly facilitate yard work near the close of the short winter days.

The entire front building, including the offices, tool rooms, pattern shop, pattern storage loft, drawing room, etc., should be lighted by incandescent lamps, those in each room being arranged to suit the peculiar conditions in each case, as to the kind of shades and reflectors employed.

To equip the entire plant as described above will require, say 27 arc lamps and 267 incandescent lamps, the latter number being somewhat lessened or considerably increased according to the character of the machinery to be manufactured, as whatever change in this respect is made would most likely affect the incandescent lamps and possibly the arc lamps as well.

In providing for the amount of current necessary to supply this system of lighting we should make allowance for any possible increase that may be called for by unforeseen circumstances, or by a change in the products of the concern, and it would usually be safe to add for this purpose at least ten per cent.

The power necessary to run the dynamos with the added ten per cent. will be about 30 horse power for the arc lamps and 20 horse power for the incandescent lamps, or a total of say 50 horse power to be provided for, in calculating the capacity of the proposed engines.

By referring to the general plan drawing published in this series in the October, 1902, number, the arrangement of the lamps as herein described may be readily understood.

PISTONS AND PACKING RINGS.—3.

J. H. DUNBAR.

A friend has called my attention to an unintended omission in the first of these letters, of his favorite, the Corliss piston. While it is out of the question to show all the various pistons made, it was an oversight to neglect one so popular as the Corliss. Figs. 1 and 2 show my friend's preference of pistons.

The Corliss piston as I have seen it made, consists of a spide, follower, a T-bullring and what is practically a single packing ring, together with the necessary studs and setscrews. Fig. 1 is an end view of the top part of the piston as it would look if the follower was removed, and the T-ring faced off flush with its groove for the packing ring. Fig. 2 is a vertical section through the center of that part of the head shown in Fig. 1.

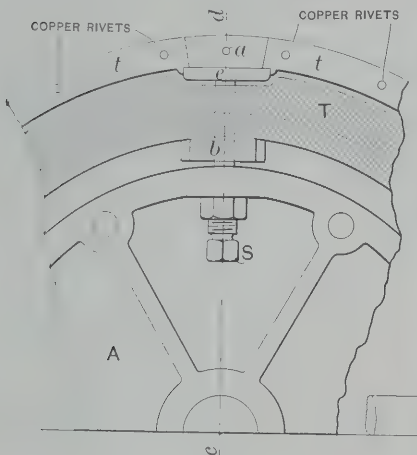
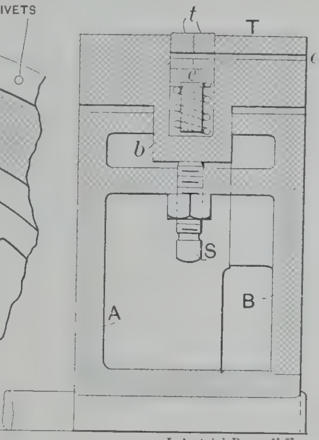


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

The follower and spider form a groove in which to grip the stem of the T-ring, which can be adjusted to keep the spider in the center of the cylinder by the setscrews striking the hub *b* on the ring. The T-ring, besides having a groove for the packing ring has radial holes drilled down to the hubs to receive a helical spring made of German silver, and the stem of a cover piece, marked *e*. Two packing rings are made and cut into eight sections usually, then riveted together so they will break joints when they are placed in the groove; the cover piece fits under these joints and stops any leak that would otherwise be there. They also set the packing ring out to the cylinder and keep it from revolving in the groove. The small holes marked *a* are drilled through one end of the T-ring and through the packing ring at its joints. Wires in these holes hold the packing ring in the groove while the piston is put in or taken out of the cylinder. If the ring is considerably worn the wires cannot be used in taking the piston out. A piece of sheet iron should be put in the counterbore to keep the ring from springing into the port as the piston is taken out of the cylinder.

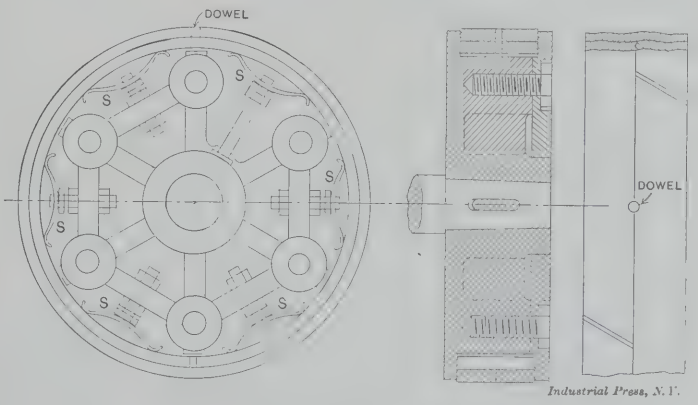
My recollection of these pistons is that they were hard on the bottom of the cylinders. There was a generous amount of wearing surface on either side of the packing ring and the steam load on top of the T-ring should have held it to the bottom of the cylinder, to some extent at least, in proportion to the area of contact and the steam pressure; thus producing an unnecessary amount of friction and consequent wear. This piston may be very much simplified by making it in one piece, and while there would be no means for vertical adjustment to compensate for wear there are no parts to get loose, and first cost is reduced. Again an engineer cannot "monkey" with it, and with the vibrating rod-packing there is not the necessity for exact piston adjustment there used to be. The packing ring, *per se*, is an excellent one. It has plenty of radial stock to wear away before a new one is required on that account, and it is an important thing to leave two wearing surfaces, when they get properly "skinned," alone as long as they can be. Its radial depth minimizes groove wear and also steam leakage around the ring. From a standpoint of intrinsic worth, based on its chances for long life and effectiveness, it certainly heads the list. The Corliss piston and packing ring do not seem to be well mated. The efficiency of the ring is handicapped by the anti-efficiency of the head.

There is no rule that I have seen by which to determine the size to make the piston head. Of course it must be some smaller than the cylinder, even if both are the same temperature. If pistons are made 1-64-inch to the foot smaller than the cylinder it will allow the piston to get 200 degrees F. hotter than the cylinder without sticking. I cannot think of any condition calling for a greater allowance for difference in the two diameters.

There is another piston, quite different from any that I have spoken of, which has done excellent service, and was popular forty years ago. "Three-ring packing" is the only name I knew it by, and I take it that the reader is more interested in the detail itself than in the history of it. There are lots of pistons made now with three or more rings in them, but the piston to be described is in a class by itself, and represents the practice of, say fifty years ago. It is shown in Figs. 3, 4 and 5. It consists of two outside packing rings and one inside, which is as wide as both outside ones, a spider, follower plate, bolts, setscrews and elliptical springs. Fig. 3 is an end view of the piston with the follower taken off. Fig. 4 is a vertical section through the center of the piston, after the follower has been replaced. Fig. 5 is a plan view of the rings showing how they are cut and doweled to keep them in that relative position.

The packing rings were turned the size of the cylinder, or if there was any difference, slightly larger. The elasticity of the elliptical springs *s, s, s, s, s, s,* were depended on to keep them set out to the cylinder to compensate for wear. In the larger sizes a bar was cast across from bolt boss to bolt boss, which made the spider much stronger than it would be without them, and also came handy to support the setscrews. For the smaller pistons, these bars were omitted and setscrews with T-heads were used, which were fitted in a slot in the hub of the spider. Both styles are shown in Fig. 3. The spiders that were bored, tapered and keyed to the rod seldom came loose, but they were the exception. The pistons I refer to were used in engines driving saw mills in the timber districts of Ohio and Indiana.

The engines were with few exceptions, between 7 and 14 inches in diameter, and generally short stroke, say 8x10 inches. The small engines were direct connected, that is, the engine crank was on one end of the shaft, and about a 66-inch circular saw on the other end. These would now be called "unit" mills. The others were belted from a pulley on the engine shaft to a smaller one on the saw mandrel. The unit mills had the preference, because they could be moved in the woods easier than the other kind, and in either case it was easier to move the mill than the woods. The mills were run only in the winter, or rather, when farm-work could not be profitably done; hence a mill crew was liable to get scattered during the summer, and it was not unusual to make an engineer out of a boy who the winter before had worked at logging. This way of making engineers was a good thing for machinists sometimes. I will, with the editor's permission, keep on digressing, and relate an instance.



Industrial Press, N.Y.

Figs. 3, 4 and 5.

My boss sent me out to fix up a mill where the only trouble was that they could not keep up steam. This might be caused by wet slabs and saw dust, a hole through the side of the chimney, a very dirty boiler or flues, or rain falling on the exposed boiler. Then the conditions of the engine or mill might be factors in the problem to be considered. To some it might not be thought fun to ride seven or eight miles in a wilderness on a log wagon, drawn by a yoke of oxen, and most of the way over a new road which was sixty-nine per cent. stumps, the balance corduroy. I did not enjoy the prospect myself, and the boss, quick to guess that I had a kick coming, side-tracked it by saying that it would be some easy job; it would be a change and give me an opportunity to exercise my ingenuity and skill, etc., but the taffy that stuck was that I should get a dollar a day extra while I was gone.

When we got close to the mill, I thought that I had located the trouble, judging by the sound which came from the top of the exhaust pipe, which was more of a roar than a lively succession of puffs, as it should be. The first thing done was to stop the engine in a position when the slide valve would cover both steam ports. Then the throttle was opened, but no steam was seen to escape from the exhaust pipe, showing the valve to be O. K. The piston was next tested by shutting off the steam, turning the engine on the quarter and hooking a tooth of the saw over a crowbar placed on top of the saw guide to hold the engine in that position, then opening the throttle again. It was not necessary to go out to look if the steam was escaping; it could be heard blowing through, or past the piston. I had expected then that a spring bolt had got free and pounded a hole through the spider and follower, as was sometimes the case, and let the steam blow through the holes. I was mistaken, however, and most happily so too, for in that case it would have necessitated another trip, which was barely to be thought of in my shaken-up condition. The trouble was caused by the jam-nuts working loose and letting the packing rings down. It was but a short job to re-set the rings and make the several parts of the piston as secure as possible.

A search for further trouble resulted in not finding any; then the mill was started and went off just as though nothing had happened. Right here I want to say that it was a standing order in that shop that the first thing a man must do after shutting an engine down was to make a personal inspection of the safety valves, and I believe it a duty every one who is called to work at isolated steam plants should perform. Of course this is unnecessary where competent engineers are employed.

About three weeks later I was sent to this same mill to remedy the same trouble as before, with this positive injunction, "to set that packing out so it would stay set." No taffy this time; just plain, every-day business. When I got there I learned that the "engineer," in hopes to stop the leak at the top of the exhaust pipe when the engine was running, had set the packing out every night as soon as the mill was closed. He was evidently acting on the general principle that if a little set was of such great good more of it would be better. Up to this time there was a question in my mind as to whether I ought to return the extra dollar which I had received for the first trip. Well, the information which I have just related as to the cause of this trouble put a quietus on that doubt, and gave assurance that my time put in on this trip would be at the same rate of pay as on the former one.

On removal of the follower I found but little left of the outside rings, and that the dowel pin in the inside ring had scored a groove in the top of the cylinder which one could lay a finger in. We got the cylinder off the bed-plate that night and loaded on the wagon ready for an early start for the shop in the morning, where the trouble was remedied by boring the cylinder and making a new piston complete. Incidentally, I remarked to my foreman, after explaining to him how it happened, "that I hoped he would succeed in making the new set of packing so it would hold together longer than three weeks." He replied that he would do his best to make the new rings "fool proof," and he succeeded to an extent much greater than he had expected. He made the outside rings as before, but the inside one he had made enough larger to set the outside ones out to the cylinder, and also had it made eccentric, so its pressure would be more uniform on the other rings. Two springs and their setscrews were used at the bottom to raise the head with, as the rings wore down. The others were left out, making a piston of fewer pieces and practically as good.

As a moral, I want to say that just because a young fellow makes a big mistake at the start, it is no proof that he is going to keep at it all his life. That all depends on the kind of stuff he is made of. The boy in question not only learned how to make a success of running an engine, but also lathes, planers, etc., and then became a mechanical engineer.

* * *

STRENGTH OF COUNTERSHAFTS.

FRANK B. KLEINHANS.

There is scarcely a shop in existence which has not had a more or less serious accident from a countershaft some time in its history. It may have been caused by a heavy pulley running very much out of balance, or the shaft may have been bent in the beginning. Possibly the shaft was too light, or too long between hangers. The latter is responsible for most of the trouble, and is the one with which this discussion is principally concerned.

There are two methods in vogue for turning cones and pulleys; one is to set the rough casting to run true on the inside, and the other on the outside. This latter method makes a cheaper and an easier job, but when turned it requires an enormous amount of metal to balance it. And here is the source of considerable trouble. You may balance a large cone perfectly on straight edges, but that is a standing balance only; and when the cone is put in place and speeded up to several hundred revolutions per minute, it shakes, and shows that it is decidedly out of balance. The trouble is you have not placed the balance weight directly opposite, or in the plane of the heavy portion of the cone. The result is that neither weight, when rotating, has its counterweight pulling in the same line, and of course the pulley is sure to be out of balance. All cones and all other pulleys which have a wide face should be set to run true on the inside before turning.

A certain countershaft failed because it had been welded near the center. The weld twisted and bent open, and some one was badly injured by the fall. A weld in machine steel is so very uncertain that it should never be trusted for such a purpose. The extra expense of a new shaft would not warrant the hazard of such a risk.

Another countershaft failed in what was, at the time, considered a mysterious manner, as the shaft was strong enough to resist either bending or torsion. The trouble was that shaft was that it had too much spring. The countershaft was loaded with several heavy pulleys, and the irregular pull of the belt set the shaft to vibrating. Each little impulse was added to the other, and this being increased by the momentum of the moving mass of the pulleys, finally caused the shaft to fail.

In the calculation which follows the spring of the shaft is limited to .06 of an inch. There are plenty of counter shafts which have been running for years with about this much spring. Now, from the general formula for the deflection of a simple beam, we have:

$$\text{The deflection, or spring} = \frac{W L^3}{48 E I}$$

In which W = the load at the center in pounds.
L = the length between center of hangers in inches.
E = the coefficient of elasticity = 29,000,000.
I = the moment of inertia of the cross-section of the shaft.

For a round shaft,

$$I = \frac{\pi d^4}{64} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

In which d = the diameter of the shaft in inches.

We then have:

$$\frac{W L^3}{48 E I} = .06 \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

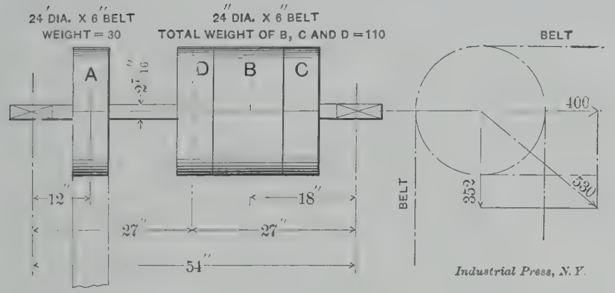
From 1 and 2,

$$\frac{64\,W\,L^3}{48\,E\,\pi\,d^4} = .06$$

$$L = \sqrt[3]{\frac{.06 \times 48\,E\,\pi\,d^4}{64\,W}}$$

$$= \sqrt[3]{\frac{.06 \times 48 \times 29{,}000{,}000 \times \pi}{64} \times \frac{d^4}{W}}$$

$$= \sqrt[3]{4{,}100{,}000\,\frac{d^4}{W}} \ldots\ldots\ldots\ldots\ldots (A)$$



Industrial Press, N. Y.

Fig. 1.

Fig. 1 shows a countershaft which is in actual service and which we know is all right. *A* and *B* are keyed to the shaft. *C* and *D* are loose pulleys arranged for open and cross belts.

A weighs 30 pounds, and *B*, *C* and *D* weigh 110 pounds. The belts run as shown in the figure. If *A* weighs 30 pounds and the centers of the hangers are 54 inches, then by taking the left hand hanger as the center of moment, we have $30 \times 12 = x \times 27$, when x is the weight at the center. Solving we find

$$x = \frac{30 \times 12}{27} = 13$$

In the same way, by taking the right hand hanger for the center moment, we find that

$$x_2 = \frac{110 \times 18}{27} = 73$$

As to the belt pull, it is possible for a single belt to run up to 70 pounds per inch of width of belt, and a double belt can be taken at 100 pounds. As a double belt is used in this case, and as the slack side of the belt is very loose when the tight side is pulling its maximum, we will take the pull at the pulley, $A = 6 \times 100 = 600$ pounds, and getting this in terms of a load at the center, we have

$$x_3 = \frac{600 \times 12}{27} = 266$$

the downward pull is 13 + 73 + 266 = 352.

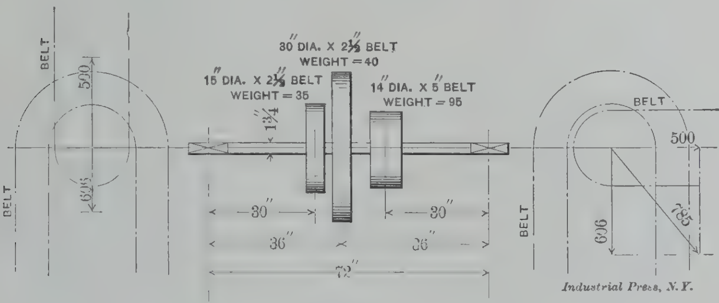


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Fig. 2.

The pull at the pulley *B* will be 6 × 100 =600, and by transferring this to the center we have

$$\frac{600 \times 18}{27} = 400$$

The resultant of these two forces will be the diagonal of the force diagram, and is equal to 530 pounds, which is equal to *W* in the formula. Introducing these terms in equation (A) we have

$$L = \sqrt[3]{4{,}100{,}000\,\frac{(2.44)^4}{530}}$$

and by solving we find L = 65, which means that for this condition of loading the countershaft would be safe with the hangers 65 inches apart.

Fig. 2 represents another countershaft taken from actual service. It is belted as shown on the left hand view, and is running all right, although it looks rather flimsy and one would consider it unsafe. Taking the moments of the weights of the pulleys and belt pull about the right and left hand supports, and finding the equivalent pull at the center, we obtain:

Weight at center due to pulleys =	148
Pull on 30-inch pulley, 2½ × 100 =	250
Pull on 15-inch pulley, 2½ × 100 = $\frac{250 \times 30}{36}$ =	208
Total downward pull =	606
Pull on 14-inch belt, 5 × 100 upward pull =	500
Resultant downward pull =	106

Introducing this value of W in equation (A) we have,

$$L = \sqrt[3]{4{,}100{,}000\,\frac{(1.75)^4}{106}} = 71.3$$

This is practically the distance at which it is running, but it shows that it is the greatest distance apart at which it would be safe to place the hangers. If the belts ran as shown in the right hand side of Fig. 2, we would then have:

Weight due to pulleys (as before) =	148
Pull on 30-inch pulley =	250
Pull on 15-inch pulley =	208
Total downward pull =	606
Horizontal pull on 14-inch pulley, 5 × 100 =	500

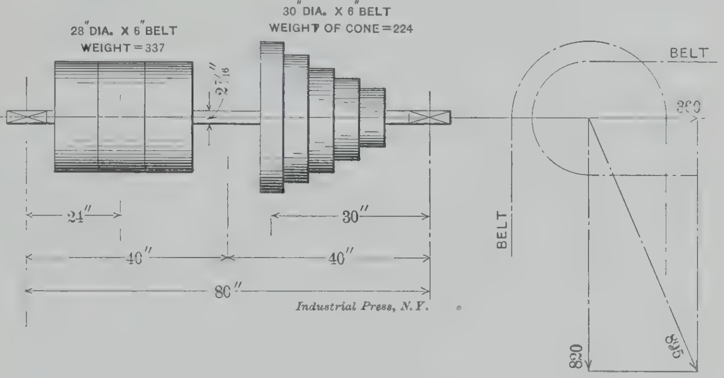

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Fig. 3.

From these two forces we find a resultant of W = 785. Substituting this in (A) and solving as before, we find L = 37, which is the greatest safe distance between hangers for this condition of loading.

There are cases where one must have an extra long shaft in order to work in the pulleys, cones, etc., as shown in Fig. 3. Here the downward loads amount to 820 pounds, and the pull at right angles amounts to 360 pounds. The resultant, 895 pounds = W.

Introducing in the formula we have

$$L = \sqrt[3]{4{,}100{,}000\,\frac{(2.44)^4}{895}} = 55$$

This means that for this condition of loading, the center should not exceed 55 inches, and since in this particular case it could not be made as small as this, the pulleys should be arranged to accommodate a third hanger.

In every case, therefore, where the centers are so far apart as formula (A) would indicate to be unsafe, a third hanger should be used. If all the flimsy countershafts had a third hanger added to them there is no doubt but that the number of accidents would be greatly diminished. In the above calculation the weight of the countershaft has not been considered, as it is usually very small. If the belts run at any other angle than that shown, the construction is made in exactly the same way, using the required angle instead of a right angle, the resultant of the two forces being used as W in the formula.

NOTES FROM MANCHESTER, ENGLAND.

Editor MACHINERY:

Some account of events and developments during the past year in the Manchester (England) district may be in order.

An interesting item was the inauguration of the Manchester Municipal School of Technology, by Mr. Balfour, the British Prime Minister. This institution is splendidly equipped in every department, and is considered one of, if not the best, in Europe. Mr. Reynolds, the principal, is, however, much troubled at the fact that British employers have not yet accustomed themselves to the idea of utilizing the services of the graduates by placing them in such probationary posts as will admit of their adding the concrete training of the works to the more or less abstract—though desirable—training provided by the school. However, there are signs of a change for the better in this respect, the President of the Manchester Association of Engineers, in his inaugural address having recently pleaded for more patience with the shortcomings of the college students, in consideration of their potential value; and some employers, at least, are considering how this particular class of ability can best be availed of.

A valuable addition to the defensive forces of the country—judging by the fine record of the Crewe, electrical and other volunteer engineers in the recent war in South Africa—takes the form of a volunteer engineer battalion raised in the Manchester district—the School of Technology having been prominent in raising recruits and being about 500 strong. Very instructive training in the way of military bridge building and other field work has been imparted during the summer months, and it is hoped to raise an additional company from the staff and workmen of the British Westinghouse Co., whose works are now getting fairly into swing.

One immediate effect of the establishment of this concern is to cause the services of efficient toolmakers to be at a premium. All the better. In conjunction with the engineering department of the local School of Technology, the Council of the Manchester Association of Engineers are conducting a series of experiments, with a view to ascertaining more definitely than is the case at present, the relative merits of the new high-speed cutting tool steels, as compared with the general run of crucible cast tool steels. A specially powerful lathe has been lent for the experiments by Messrs. Armstrong, Whitworth & Co., and the results of the trials will be published in the transactions of the Association.

The new Education Act, which comes into force very shortly is a decided step in advance in many ways. It provides for more efficient staffing and supervision of primary and secondary schools; and the manner in which the municipal and other local governing bodies are setting to work by appointing committees to carry out the Act, representative of scholastic, administrative, and industrial experience, augurs well for the educational equipment of our future workmen and industrial directors.

A visit, which has, no doubt, attracted attention in America has been taken part in by representatives of a number of British trade unions. Mr. Alfred Moseley, a London merchant, offered to bear the expense of a visit to the principal industrial centers in the States, the idea being to provide an opportunity of comparing the manufacturing methods and labor conditions of the two countries. Reports from the delegates are just appearing, and though credit is given for many valuable American features, it is not considered, on the whole, that the American worker is really better off than his British compeer. According to the Cotton Trade representatives, cotton mills in the southern states are reproducing many of the most objectionable features of the first period of factory life in England—that of child labor. Alabama and Georgia are particularly reprehensible in this connection.

The Northrop loom, as manufactured by the Draper Co., of Hopedale, Mass., was the subject of special investigation, and though it is considered that little would be gained in Lancashire by its sudden adoption, it is recognized that looms built on analogous lines, and worked on a somewhat identical system will probably need to be gradually introduced, and modified to suit local conditions and markets. Mr. T. M. Young, who recently contributed a series of interesting articles on the American cotton industry to the Manchester Guardian, reported a case where makers of automatic looms executed an order for 1,000 machines, taking the non-automatics in exchange. It was pointed out as an economic curiosity, that whereas the early cotton operatives smashed newly-invented machinery to prevent its displacing the old, the old looms in this case were smashed before leaving the mill, by the makers of the new, so that they might never come into competition with their own make.

Touching on conditions in engineering workshops, and daily life, in the States, Mr. M. Arrandale, secretary of the United Machine Workers—planing, drilling, milling, etc., machine operators—reports as follows:

The American worker receives much higher wages than we do in this country, but, on the other hand, the necessities of life cost much more; house rent and railway traveling are much dearer; food in many cases is also much dearer; more money is spent by the American worker in amusements, and domestic life altogether is not nearly so comfortable as in this country. Referring to works visited in one city, Mr. Arrandale declares they were carried on "under about the worst conditions that men could be found to live in, if living it could be called. I found traveling cranes running from end to end of the place, in some cases carrying enormous weights, not always slung in the safest manner. It is no uncommon occurrence for half a dozen men to be injured or killed by the weights falling, almost every day." Again, "some employers in the States seem to value their machinery a great deal more than their work people. I also found through the whole of the country that there is not the slightest regard for life or limb. The human being is often looked upon as of no value and to be more easily replaced than the machinery." He sums up as follows: "The lot of the worker in this country is equal to, if not better, than in America.

Recent additions to the engine and machinery manufacturing facilities of this district include large extensions to the works of Mather & Platt; Armstrong, Whitworth & Co., etc.; while Trafford Park has received additions in the shape of the new branch works of Messrs. Royce, Ltd., electrical engineers.

Large orders for locomotives have been received by Messrs. Beyer, Peacock & Co., Ltd., and on the whole there appears good reason for believing that the Manchester district will long remain the center of an important and far-reaching engineering industry.

JAMES VOSE.

Manchester, Eng

* * *

THE INFLUENCE OF COST ON MACHINE DESIGN.

The *Mechanical World*, in commenting on engineering text-books, ancient and modern, says that there are a few good books on the steam engine and its design, but intimates that not one of them indicates the comparative cost and time of production of the component parts, or the comparative cost of different types of engines of the same power. The same fault exists in the teaching of the technical schools. The belief is expressed that not one student in a hundred has any notion beyond a mere guess of the comparative cost of the different parts on which he devotes so much study. Neither is he in a position to estimate, say, whether a reduction of one-half inch in diameter of an engine crankshaft would allow the use of nickel steel in place of mild steel without increased cost, nor does he know whether the valve gear is worth five, ten or twenty times the same weight of bedplate metal. The writer believes that while it is undoubtedly unpractical to make estimates of the actual commercial costs of engines or other examples of machine design, in engineering schools and text-books, it is possible to give the students an idea of the relative costs of the component parts of any machine. Armed with this knowledge the young engineer is better equipped to calculate costs in actual engineering work since he may to a certain extent use his theoretical costs and multiply them by such coefficients as the conditions of labor and material cost may seem to indicate. It is pointed out that the question of cost alone, has a vital influence on machine design itself, aside from theoretical considerations. For instance, the young student designer should be in a position to know whether, say, a complicated steel piece that requires considerable machine work will not be more expensive and no better than a simpler and heavier cast-iron piece, etc.

NOTES ON POWER AND TRANSMISSION.

In an address before the Washington meeting of the Association for the Advancement of Science, held in midwinter, Prof. J. J. Flather reviewed some of the important features of recent progress in the field of power and transmission, taking up electrical development, gas power and compressed air. The following notes on electrical transmission and gas engine practice are abstracted from the address:

The labor cost in machine shops is so much greater than the cost of power that any expedient by which the former may be appreciably reduced is justified, even though the efficiency of the agent itself is low. While the efficiency of electrical transmission is not the essential, so essential is the efficiency of the tool in turning out work, comparative figures upon cost of transmission are not without interest. Prof. Flather says: The percentage of loss due to shaft friction in railroad and other shops where buildings are more or less scattered may be 75 per cent. of the total power used. In two cases known to the writer, these losses were 80 and 93 per cent. respectively, and in the ordinary machine shop they will probably average from 40 to 50 per cent. In view of these losses there is a general tendency towards hollow and lighter shafting, higher speeds and lighter pulleys, roller bearings in shaft hangers, and the total or partial elimination of the shafting, through the use of electric motors, either for independent or group driving.

A modern shop generator belted from an engine will have an efficiency of about 90 per cent. when working under favorable conditions, but as the average load is ordinarily not more than two-thirds full load, and often much less, the efficiency will not usually be more than 85 per cent. Since the engine friction was included in the figures above, so also it should be considered here, in which case the efficiency of generation will lie between 75 and 80 per cent. With a three-wire 220 volt system, which is very suitable for ordinary shop transmission when both light and power are to be taken off the same dynamo, the loss in transmission need not be more than 5 per cent., so that the efficiency at the motor terminals will not be far from 75 per cent. With motors running under a nearly constant full load the efficiency of motor may be 90 per cent.; but with fluctuating loads this may fall to 60 per cent. at quarter load.

Where cheap fuel is available it is found in most cases that electric power can be generated at the works more cheaply than it can be purchased from a central station; especially is this the case if the exhaust steam be used for heating purposes. In isolated plants the cost of transmission is very small as compared with the total cost of generation; whereas in the average central station the cost of transmission, which includes interest and depreciation on pole line, usually constitutes a large percentage of the operating cost. In those localities where the cost of fuel is high electric power can often be purchased more cheaply from a central station which obtains its power many miles distant and transmits it electrically to a convenient distributing center, where it is used for power and light. The possibility of electrical transmission thus permits of the utilization of available sources of power at great distances from the center of distribution; but while it is interesting to know that a certain amount of power may be transmitted a given distance with a high degree of efficiency, it is more important to know whether the same amount of power could be obtained at the objective point more economically by other means.

PRESENT STATUS OF GAS ENGINE PRACTICE.

The gas engine, in large and small sizes, has reached a point where it can fairly rival the steam engine in reliability and satisfactory running qualities. In point of fuel economy a gas engine of moderate size is on a parity with the largest triple expansion steam engines and it will give a horse power on one pound or less of coal. But the price of gas is so high in this country that the gas engine has been used more on account of its convenience and saving of labor than because of its high efficiency. It is true that natural gas is cheap, but it is equally true that natural gas is not generally available. Fortunately the manufacture of producer gas has reached a high state of development. The leanness of producer gas renders it less effective per cubic foot of gas, as compared with the richer coal gas, or even water gas, but this difference is more than compensated for by the low cost of production. It is upon such power gas that the commercial future of the gas engine as a general motor depends.

The producers are very simple in operation and furnish a convenient and economical means of obtaining power at a much lower rate than with the ordinary city lighting gas. Generally small anthracite coal or coke is used, but several methods employ bituminous coal, lignites, or wood. With bituminous coal, means must be provided for removing the tar and ammonia, and other products of distillation.

The gas engine industry received a signal impetus when it was discovered that blast furnace gases could be readily utilized direct in combustion engines without the intervention of boilers and without any special purifying processes. A still more important circumstance is the fact shown by Prof. Hubert, of the Liege School of Mines, that the superior economy of the gas engine enables equal power to be obtained with 20 per cent. less consumption of furnace gas than was formerly used in the generation of steam.

The successful employment of large combustion engines in this way utilizes vast sources of power which a few years ago were allowed to go to waste or at most were used very inefficiently.

The high thermal efficiency of the gas engine has long been recognized, and the possibility of further development is a promising factor in this field.

Efficiencies of 30 per cent. or more have been obtained with blast furnace gases which contain a very small percentage of hydrogen, and this, with the high rates of compression which can be carried, has led to the advocacy of non-hydrogenous mixtures in large engines. Certainly very high rates of compression may be had with a non-hydrogenous producer gas without fear of premature ignition, and it has the additional advantage of economical production.

The practice of making the cylinder in combustion engines act alternately, first as air compressor then as motor, has the advantage of greater simplicity, but it means immensely larger engines for the same power, since the number of effective impulses is thus cut in two.

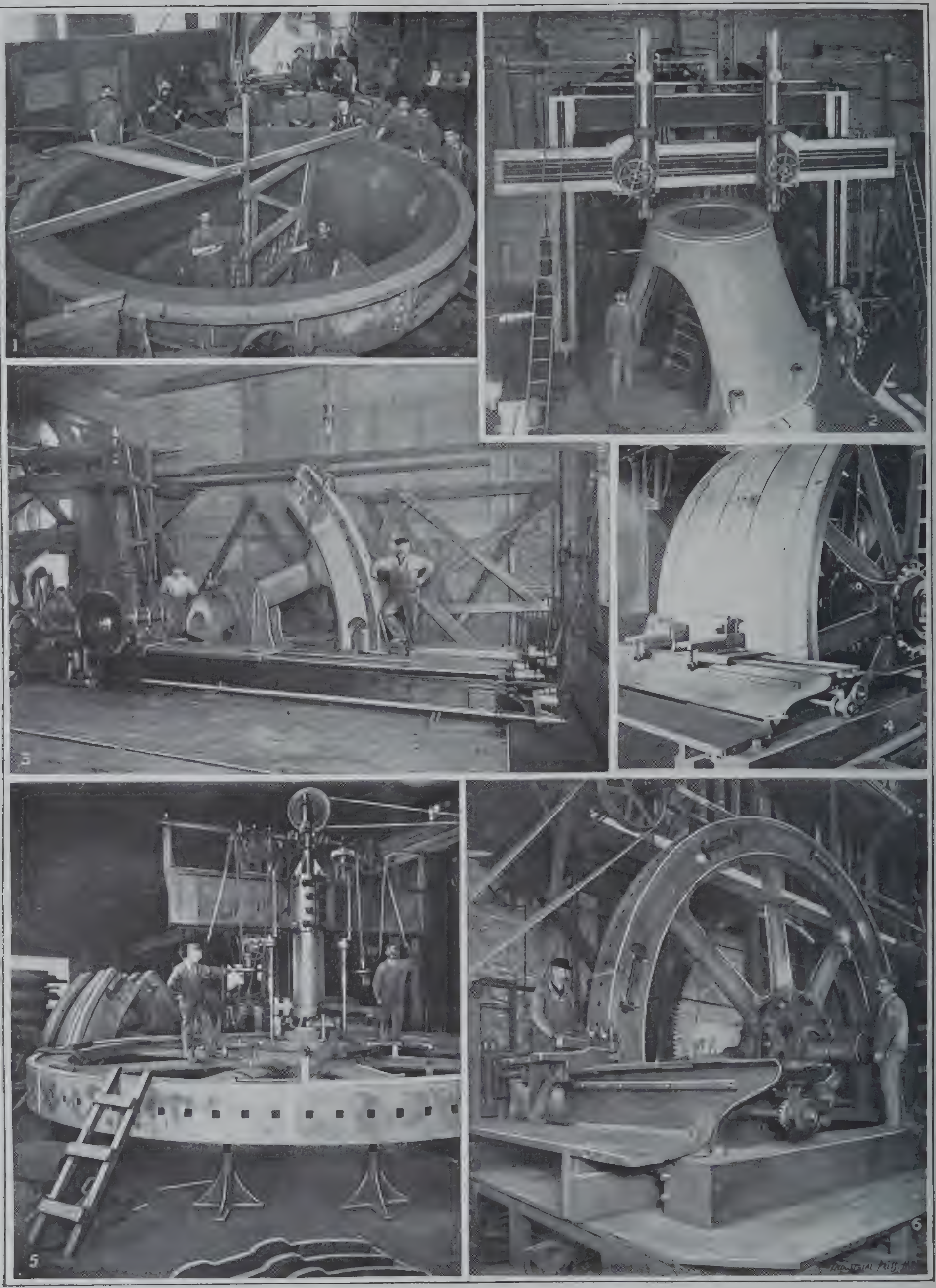
The danger of pre-ignition and consequent severe shock on the engine also necessitates very heavy construction in the larger engines in order to obtain a reasonable degree of safety in operation. Moreover, the smoothness of action is greatly retarded with this form of engine, especially if the governing is controlled by the "hit and miss" method, in which the regulation is effected by varying the frequency of the explosions, thus causing great variations in the driving torque.

Various expedients have been employed to overcome these defects, such as the use of multi-cylinders and different methods of control, but the size and cost of engines have been increased rather than decreased. Notwithstanding these well recognized defects in the 4-cycle type of engine, it constitutes by far the largest class in use to-day of what may be called successful gas engines.

Some recently very satisfactory results have been obtained in the construction of 2-cycle engines. In some of them we find separate pumps employed to compress the charge of gas and air, which ignites and burns as it enters the cylinder. Higher compression is thus obtained without fear of pre-ignition and this permits smaller clearance spaces with attendant advantages.

If the engine is single acting, an impulse is obtained every revolution, which thus insures better speed regulation as well as double the power for a given size cylinder.

The highest thermal efficiency yet attained, namely 38 per cent., has been secured with a 2-cycle type of engine, but whether these engines will be as satisfactory for small motors remains to be seen. It is possible that the greater complication of details in the 2-cycle types as compared with the simpler 4-cycle engine will cause the latter to continue to give the greater satisfaction, at least for the smaller sizes.



VIEWS FROM THE E. P. ALLIS WORKS (RELIANCE WORKS), MILWAUKEE.

1. Pit for Casting Vertical Engine Housings.
2. Housing for Vertical Engine, on Boring Mill.
3. Double Planer at Work on Fly-wheel Segment.
4. Twenty-four foot Drive Wheel in Pit Lathe.
5. Universal Radial Drill for Fly-wheel Work.
6. Twenty-four foot Segmental Fly-wheel in Pit Lathe.

VIEWS FROM THE MILWAUKEE PLANT OF THE ALLIS-CHALMERS CO.

Two months ago we published a description of the new West Allis plant of the Allis-Chalmers Co., near Milwaukee, with illustrations of the various buildings. Supplementary to this, the several views shown herewith of the Old Reliance Works of this company, on Clinton street, Milwaukee, will be of general interest. The Reliance works consist of a group of large brick buildings of a style of architecture in vogue several years ago, and while not strictly modern are reasonably well adapted to the needs of a concern building heavy machinery. If the present overcrowding can be relieved, through the removal of a considerable quantity of the work of the West Allis plant, they will be well adapted to manufacturing purposes.

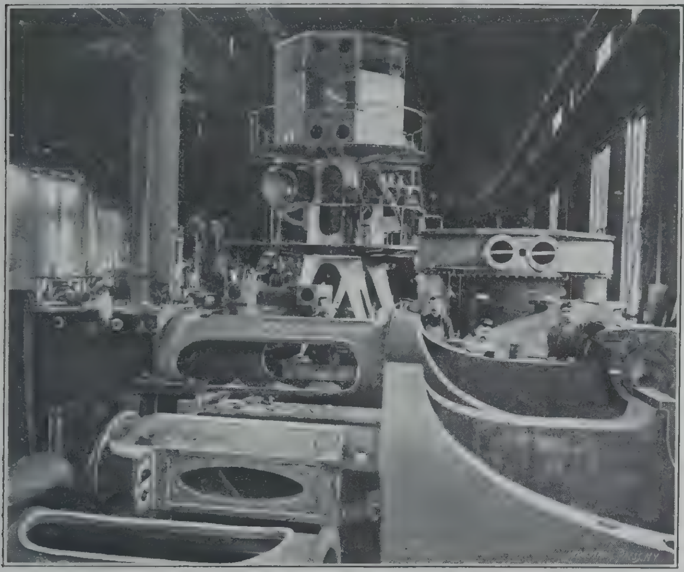


Fig. 7. General View of the Erecting Floor.

It is in these shops that the immense engine-building business of the former E. P. Allis Co. was developed, under the able management of Mr. Edwin Reynolds; and the views shown indicate the manner in which some of the heavy work has been handled. Fig. 1 of the group shows the pit in which the housings for large vertical engines are cast; and in Fig. 2 is one of these housings on a 16-foot boring mill. Fig. 1 was taken when a mold for one of these housings had been partially swept up. Figs. 4 and 6 illustrate heavy work in the pit lathe, that in Fig. 4 being a 24-foot drive wheel and that in Fig. 6 a 24-foot segmental flywheel. In Figs. 3 and 5 other work upon the segmental flywheel is being performed. Fig. 3 shows a double rotary planer facing off the sides of the arms to which the hubs of the wheel are bolted, and indicates clearly the manner in which the segments are secured to the bed of the planer, while the cutter heads traverse lengthwise of the beds and face off the casting.

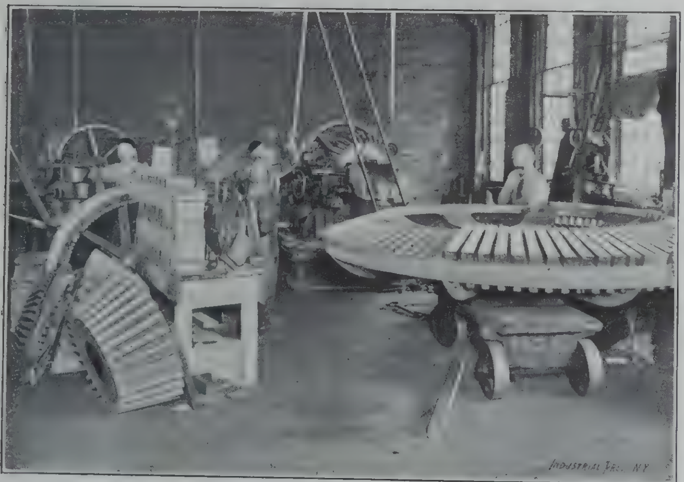


Fig. 9. Gear-making in Mill Department.

In Fig. 5 a double radial drill is in use, for drilling and reaming the holes of the flywheel hub. This drill is of special design. It is supported by a column centered by the bore of the hub. Each radial arm of the drill is in the form of a double girder, between the two sections of which the drill heads are supported, so that they may be moved out or in for drilling holes on circles of different radii. The machine is rope-driven, as indicated.

Fig. 7 is a glimpse of the erecting floor and plainly indicates the need felt by the company for more extensive quarters which are now to be had at the new West Allis plant. Fig. 8 is another view of the 16-foot boring mill, with a large low-pressure cylinder in place for boring. A fixed boring bar is used, on which a cutter head is fed downward while the cylinder rotates with the table of the mill.

Besides the engine and mining machinery work for which the E. P. Allis Co. has been best known, they build an extensive line of flour and sawmill machinery and do general mill work of all kinds. Fig. 9 shows some of this work in progress in the mill department, where there are large bevel gears with wooden teeth in process of construction. These teeth are made by inserting hardwood blocks in spaces cast in an iron body and held by wedges driven in at the back in the usual manner for constructing such gears. The teeth are then shaped by a planing machine seen in the background in Fig. 9, in which the cutter is guided by a templet.

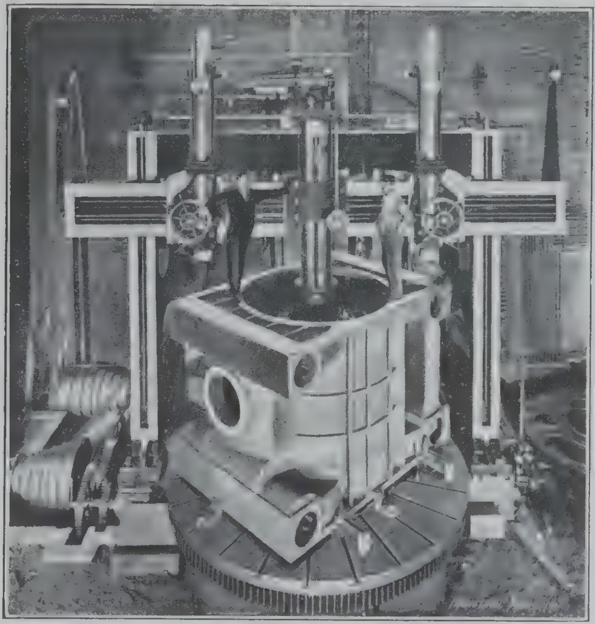


Fig. 8. Large Cylinder in Process of Boring.

* * *

The chilled cast iron carwheel so generally used in the United States is undoubtedly the highest development of cast iron founding. Hundreds of thousands of cast iron wheels are in use under freight cars where they are subjected to the severest service imaginable, yet the proportion of wheels that fail before running, say, 60,000 miles, is quite insignificant. Heavier cars are imposing harder conditions to meet, however, and many railroad men have seriously questioned the advisability of using the chilled cast iron wheel for the heavier freight cars, believing that the limits of the chilled iron wheel had been passed. But, superior product as it is, the carwheel makers do not despair of still further improving it to meet the altered conditions of traffic. In a paper read before the November meeting of the Railway Club of Pittsburg, Mr. C. V. Slocum pointed out that the advances made in carwheel making since 1888 were great. He exhibited "test bars" 1 inch square and 12 inches long that had successfully stood a transverse load of 3,500 pounds; in 1888 the best test bars failed at 1,800 to 2,000 pounds. Experiments have shown that titanium in iron gives greater density to the metal, greatly increases the transverse strength, and gives a harder chill to the tread of the wheel. This latter condition seems quite remarkable when it is known that a broken fragment of the chilled metal of an ordinary carwheel will scratch glass, being as hard or harder than hardened tool steel.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY
DESIGN—CONSTRUCTION—OPERATION.
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
66 WEST BROADWAY, NEW YORK CITY.
CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1903.

NET CIRCULATION FOR MARCH, 1903,—27,462 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

A WORD OF DISCOURAGEMENT.

Since answering "A. M." in the "How and Why" department of the last number upon the rotary engine question we have received a letter from another subscriber upon the same subject. Such letters of inquiry upon the advantages or disadvantages of rotary engines, their difficulties, the reason why rotary engines have not come into general use, etc., come to us with frequent regularity. In this instance the writer says: "For several years past I have devoted considerable time and attention to the problem of rotary steam motors or engines. As a result of my labors I have designed a machine of this type, and before taking any steps to secure a patent I desire to obtain some information in relation to the experience had by others in their attempts to solve the problem." Then follows a list of questions.

This correspondent is only one of hundreds of inventors who are now working on rotary engines and one of thousands who have worked upon them in the past. In view of the large number of patents that have been issued for "Engines, rotary," and the failure of practically all of them to net anybody any profit, except the patent attorneys and the United States government, we are constrained to offer the advice, "Don't take out a patent on rotary engines unless you can afford to lose the money you put into it."

Many people seem to think that the rotary engine is an unsolved problem, which thousands have been trying to solve without success and which will eventually be solved by some lucky fellow who happens to strike the correct idea; and so every inventor who has taken up the question has had visions of being the one man to reap the final success.

We do not look upon it in this light. What are the difficulties in the way of a satisfactory rotary engine? Mainly three. First that of unequal wear of the rotating parts, owing to their varying diameters; second, large clearance spaces and the supposed necessity for late cut-off; and third that to obtain a large amount of power the engine must either run at abnormally high speed or be excessively large in diameter. These difficulties do not seem insurmountable by any means, and there are probably several designs which remove the first two objections almost entirely. As to the last, high speed is not so objectionable now as formerly, in view of the developments in electric generators.

The whole trouble with the rotary engine "problem" is that there is no problem there needing solution. From the standpoint of the inventor it has been solved many times over. Amid all the worthless trash in the way of rotary engine patents that have been ground out in the patent office there have been a few having the elements of success and if properly developed would undoubtedly make satisfactory engines for certain purposes. There is a rotary engine made in Sweden that has proved quite popular for driving fans and other machinery of light power, and we have occasionally seen models of engines in this country that would undoubtedly run well and wear well and might prove very good motors. We believe that with all the time that has been spent in perfecting the rotary engine there is very little left for inventors to do and that further patents on rotary engines are not likely to net their inventors much if any greater returns than have those of the past.

Why then, have not some of these engine designs been sought out by investors and placed on the market? Not for lack of capital, for there has been plenty of money available for investment where there was a reasonable assurance of fair returns. If rotary engines would accomplish half what was claimed for them, there would be no trouble in financiering the project.

The only plausible answer to the question is that there has been no demand for rotary engines. The demand has existed in the minds of inventors only. There was nothing to indicate that a rotary would be any better than a reciprocating engine and people have let well enough alone and contented themselves with what was already giving good results. In the way of a ray of hope, however, it is only fair to say that the demand for engines of the rotary type promises to be much greater from now on because of the adaptability of such units for direct coupling to electric generators, a condition that did not exist a few years ago. But there is every indication that the turbine is better adapted for this purpose than the rotary engine, especially for large power, so that the "ray of hope" is not a very bright one and we see no reason for modifying the title of this editorial.

* * *

SHOP ACCIDENTS.

In the letter from our contributor, Mr. James Vose, published in another column, upon the industrial conditions in the Manchester, Eng., district, reference is made to the findings of the Moseley commission which recently visited this country and to which we have referred editorially. Mr. Vose quotes one of the members upon the iron-working industries of this country, who arrives at the conclusion that the workmen in England are on the whole as well off as workmen in this country. We have no disposition to question this because the arguments pro and con seem to balance up quite evenly. The machinist in this country earns more money and pays more for what he buys; presumably also he is able to purchase more things, though not necessarily things that add to his material comfort. The fact remains, however, that there is a certain pleasure in being able to handle money and to purchase articles, even though in the end one is no better off; and the result is that English workmen come to this country, like it, and make their homes here.

One allusion to the dangers to which American workmen are subjected and their liability to accidents in American shops, we believe in one way to be a just criticism and in another way, not. Probably precautions are not taken in this country to avoid accidents such as are taken in England; and it may be that in manufacturing establishments the percentage of those injured is greater here just as the percentage of the injured is greater in railroading. This is a point that should not be considered too lightly by manufacturers, as possibly it may be in steel and iron works and other places where a great deal of cheap labor is employed. On the other hand there is a very marked tendency to abolish labor in places where danger exists. The number of laborers employed in machine shops who handle castings or machinery is not nearly so great in proportion to the work turned out as formerly, and the very appliances that the representative quoted by Mr. Vose condemns, namely, the overhead traveling cranes, have done more to reduce the number of accidents than almost any other one improvement. While the bustle and whirl of a modern machine shop are confusing to one not accustomed to American methods, the improved appliances for handling heavy masses are certainly a long step towards making the conditions safe for the machinist.

* * *

INSURANCE ENGINEERING.

Plans are maturing for a course in insurance engineering at the Massachusetts Institute of Technology. This will be brought about at the instigation of the Factory Mutual Insurance Companies and particularly of the Boston Manufacturers' Mutual Company. It is believed that the time has arrived when young men trained in the subjects of fireproof construction, fire hazards, the prevention of fire and kindred topics can do effective work in reducing the immense annual loss through conflagration. Edward Atkinson states that the ash heap in the United States in 1901 cost $150,000,000 directly, and $100,000,000 more through the expenses incident to conducting insurance companies, water works, fire departments, etc. This amount is considerably more than the annual appropriation for the public schools, and more than double the amount spent annually for colleges and technical schools —yet there is no school at present where the question of the prevention of loss by fire is taken and studied in a systematic manner.

An idea of what might be accomplished through such a department can be inferred from the records of the various companies of the factory mutual system of insurance. This system was organized 60 years ago, with the fundamental idea of preventing loss by fire among the different subscribers, through rigid inspection, the removal of fire risks and investigation of the causes of fire; and then paying "insurance" for such losses as could not be avoided by the precautions that were taken. It will be appreciated that this is quite different from the usual plan of insurance where, in too many cases, strenuous objections are raised by the owners of property to introduce safeguards; or at least, if these are adopted, it is done to "satisfy the insurance company" merely.

The mutual system was started among textile mills and has since spread to machine shops and other kinds of factories. It was found that heavy losses had been incurred through such simple causes as the breaking of watchmen's lanterns; the use of gear-driven instead of friction-driven fire pumps, in which the teeth frequently broke when starting; the use of animal insteal of mineral oils, leading to spontaneous combustion, and the common plan of constructing buildings with enclosed spaces in the walls under roofs, where fire could obtain headway unchecked, or rats' nests could be built of oily waste. Work was directed toward doing away with these and many other hazardous conditions, and statistics show that the results have been remarkable. During the last six years, in which period the safeguards against loss by fire in all the main works of the mutual companies have been substantially completed, the actual losses have come to about 27 cents per $100 insured for the whole term of six years. Contrasting this figure with the average to the community outside the Mutual risks, which, on the whole, are considered less hazardous, because of the less dangerous occupation of the occupants, the average loss has been from 50 to 60 cents *for each year*—not for the six years. In other words, by developing the study of fire prevention the Mutual companies have reduced their losses to about one-twelfth those where less systematic effort is made to this end.

It would appear, therefore, that there was excellent opportunity for a course in insurance engineering and that graduates from such a course would have a chance to do excellent work for the community as well as for themselves. The Manufacturers' Mutual Insurance Company has organized an insurance experiment station as a preliminary to this course and which, it is expected, will eventually be taken by the Massachusetts Institute of Technology. This station is now issuing bulletins at intervals, sold for a nominal sum, and our article this month upon slow-burning construction for mills and factories is taken from one of these bulletins.

NOTES AND COMMENT.

A feature of the Varied Arts Building of the St. Louis Fair is that ten portrait statues, each 12 feet high, will surmount the columns of the curving colonnade which forms the main entrance on the south facade. The statues will be those of the great inventors who have done most for the development of the various industries by means of their inventions. They are Howe, inventor of the sewing machine; Fulton, the steamboat; Bessemer, steel; Chickering, piano; Clark, telescope; Ericsson, monitor; Watts, steam engine; Colts, firearms; Hoe, modern printing press; Goodyear, rubber.

In discussion before the Institution of Mechanical Engineers Mr. J. H. Wicksteed stated that in English practice it was customary to design machine tools so as to allow 150 feet run of belt for each foot of surface speed of the work. Allowing the maximum pull of a 4-inch belt to be 200 pounds, the theoretical pressure developed on the tool would be 30,000 pounds, which, by frictional resistance, would be reduced to say, 20,000 pounds. In the same discussion Mr. H. F. Donaldson, who read a paper on the cutting angles of tools stated that a friend had designed a boring tool having the cutter ground at such an angle that when it was once started in the work, it would feed itself.

The *Electrical World and Engineer* estimates that the lead cell of an automobile storage battery is capable of lifting its own weight through a height of 5¾ miles in expending its energy without waste. Compared with a piece of good coal, however, it should be remembered that the latter contains enough potential energy to lift its weight 2,000 miles against gravitation so that a lump of coal is 350 times richer in energy than a lump of storage battery. But we can use only five per cent. of the energy of coal in an automobile, whereas we can get 20 per cent. usefully out of a storage cell, at the motor axles; so that the disparity is reduced from 350 to about 20. Even at 20 to 1, the energy storage capacity of coal or petroleum is clearly much greater than that of electric storage cells.

Mr. E. G. Constantine, in an address before the Manchester Association of Engineers has this to say about industries in England and America: Last year I spent a few weeks in the United States, and I am free to confess that I was very considerably impressed by some of the methods in vogue in that country. Any expectations of finding the men working excessively hard were not realized; in such works as I visited—and I spent a good deal of time in some of them—I failed to discover any evidences of exhausting labor, but on the other hand there was an absence of that happy-go-lucky, wandering-about-with-a-piece-of-wood fashion, which we are so painfully conscious exists in some of our works in Britain. Each man appeared to know his job, and to stick at it, and sullen faces were the exception. In the administrative and commercial departments the contrast between American and British practice was startling, and revealed the great factors tending to the success of American enterprises—enthusiasm and loyalty.

In an article on bonding the rails of street car tracks, the *Railway Engineer* refers to some interesting properties of mercury in the following words: "It is a well known fact that mercury will readily unite and form an amalgam with almost every known metal except iron and platinum, and even these can be formed by certain roundabout processes. The mercury will touch an iron surface sufficiently well to admit of electric conduction, but it will not 'wet' it; the molecular attraction between the two is not so great as that between the molecules of mercury themselves; it is insufficient to break down the surface tension of the fluid metal. It is a matter of scientific history that so long ago as 1865 Wurtz and Crookes discovered that the addition of a very small proportion of sodium amalgam to the mercury gave it the power of 'wetting' or amalgamating an iron surface, so that iron plates could be used instead of copper in the extraction of gold from crushed rock."

THE EFFICIENCY OF MECHANISM.*

WITH SPECIAL REFERENCE TO HOISTING MACHINERY.

C. F. BLAKE.

Any combination of fixed and movable pulleys or sheaves whereby power is multiplied, enabling large resistances to be overcome, is called tackle. The most usual form of tackle is that shown in Fig. 6, in which *A* represents the fixed sheaves mounted in some portion of the machine, and *B* represents the movable sheaves in the block to which the load is attached. The sheaves are usually of one diameter, and mounted upon one pin, those in the figure being made of varying diameters to enable the winding of the ropes to be clearly shown. By means of the tables given for the fixed and movable pulleys, we may obtain the efficiency of any arrangement of tackle. Inasmuch as the tackle shown represents a large majority of that in use, it is well to investigate the efficiency of such tackle as a unit.

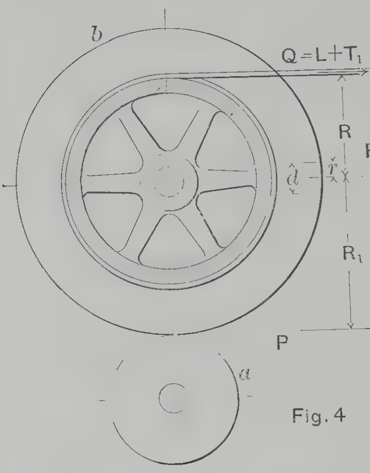

Fig. 4

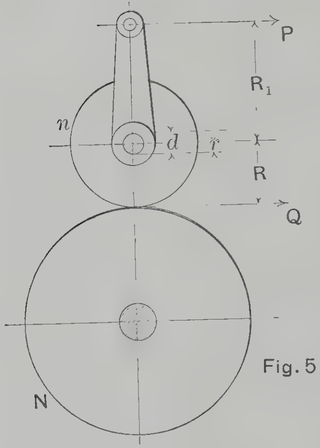

Fig. 5

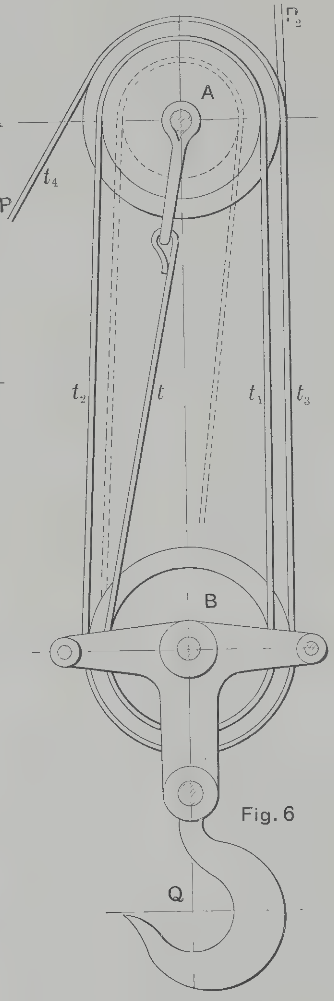

Fig. 6

Industrial Press, N.Y.

The efficiency is in inverse proportion to the number of sheaves in the tackle, which is determined by the number of runs of rope to be used, which in turn is determined (friction being neglected) by the relation

$$\frac{L}{n} = t, \text{ or } n = \frac{L}{t}$$

in which $L =$ the load, $n =$ the number of ropes, $t =$ the tension in each rope, L and t, the known factors determining n.

Thus neglecting friction and all hurtful resistances, we have

$$P_1 = \frac{L}{n}$$

Taking all hurtful resistances into account, it will be seen that the tensions in the several runs of rope are not equal. Thus if $t =$ the tension in the first rope, $t_1 = kt =$ the tension in the second rope, $t_2 = kt_1 = k^2t =$ the tension in the third rope, and $t_{(n-1)} = k^{(n-1)} t =$ the tension in the n th. rope. The power end of the rope is not included in the n runs of rope as it has no direct lifting power, the n runs including only those directly connected to the movable block.

In Fig. 6, $t_3 =$ the tension in the last run of rope, and as shown above, $t_4 = kt_3 = k^4 t =$ the tension in the power end of the rope.

In general, then, for n runs of rope, the tension in the power end $= k^n t$, or

$$P = k^n t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The hurtful resistances may be considered as added to the load, which then becomes equal to the sum of the tensions in the several ropes connected to the movable block, and we have

$$Q = t + k t + k^2 t + k^3 t - k^{(n-1)} t$$

$$Q = t (1 + k + k^2 + k^3 + k^4 \quad k^{(n-1)}) = \frac{t (k^n - 1)}{k - 1} \ldots (2)$$

Denoting the distance through which P moves in a unit of time by s, the distance through which Q moves in the same time is $\frac{s}{n}$, and the efficiency of the tackle is

$$e = \frac{\frac{s}{n} Q}{P s} = \frac{Q}{n P}$$

Substituting the values of P and Q from (1) and (2) we have

$$e = \frac{\frac{t(k^n - 1)}{k - 1}}{n k^n t} = \frac{k^n - 1}{n k^n (k - 1)}$$

The following table, No. 4, gives the efficiency of tackle under the same conditions as were assumed for single fixed and movable pulleys.

TABLE NO. 4. EFFICIENCY OF TACKLE.

Diam of Rope.	Min. Diam. of Sheave.	Value of k.	Efficiency $= e = \frac{k^n - 1}{n k^n (k - 1)}$					Average.
			Number of Runs of Rope					
			2	3	4	5	6	
$\frac{1}{2}$	10	1.081	.888	.856	.823	.793	.767	.825
$\frac{5}{8}$	12	1.068	.909	.879	.853	.826	.800	.853
$\frac{3}{4}$	14	1.058	.915	.893	.869	.843	.823	.868
$\frac{7}{8}$	16	1.050	.927	.907	.880	.861	.845	.884
1	18	1.045	.935	.915	.897	.875	.860	.896
$1\frac{1}{8}$	20	1.040	.941	.925	.898	.880	.871	.903
$1\frac{1}{4}$	22	1.036	.948	.933	.909	.897	.883	.912
	Average		.923	.915	.875	853	.835	

Winding Drums.

Let Fig. 4 represent a winding drum operated by two gears, of which the pitch lines are a and b, by means of which a load L is to be moved by the application of a force P at the pitch line of the larger gear b. The distances through which P and L move are proportional to the radii of the gear and drum, so that

$$P_1 R_1 = L R \text{ and } P_1 = \frac{L R}{R_1} \ldots\ldots\ldots (1)$$

The wasteful resistances to be overcome are: 1st. The stiffness of the rope requiring an additional force T_1, which may be added to the load L, making the total force acting in the rope

$$Q = L + T_1, \text{ and}$$

2nd. The journal friction due to the resultant pressure of P and Q, and to the weight W of the drum when wound full of rope or chain.

The stiffness of the rope may be neglected at first to be brought into the solution later, which makes $Q = L$, and assuming P and Q to be parallel, the maximum value of their resultant is $P + Q = 2L$, when the condition of equilibrium, (ϕ being the coefficient of journal friction) becomes

$$P R_1 = L R + 2 L r \phi + W r \phi = L R + r \phi (2 L + W)$$

$$P = \frac{L R + r \phi (2 L + W)}{R_1} \ldots\ldots\ldots (2)$$

Letting the efficiency of the rope $= e_2$, and neglecting the weight W of the drum and rope, we get from (1) and (2) the efficiency

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* This is the second installment of Mr. Blake's contribution on the subject, and completes the article. The first installment appeared in the March number.

$$e = \frac{P_1}{P} e_2 = \frac{\dfrac{L\,R}{R_1}}{\dfrac{L\,R + 2\,r\,\phi\,L}{R_1}}\,e_2$$

$$e = \frac{e_2\,R}{R + 2\,r\,\phi} = \frac{e_2\,R}{R + d\,\phi}$$

where d equals the diameter of drum shaft.

Table No. 5 gives the efficiency of drums for various sizes of ropes strained to their full capacity, the drum shafts being of such assumed diameter as to cover extreme practice, and the coefficient of journal friction being taken as .08.

TABLE NO. 5. EFFICIENCY OF WINDING DRUMS.

Diam. of Rope.	Min. Diam of Drum.	Value of e_2.	Assumed Diam. of Shaft.	$e = \dfrac{e_2\,R}{R + d\,\phi}$	Coef of Resistance $k = \dfrac{1}{e}$
½	10	.982	3	.939	1.064
⅝	12	.985	3½	.943	1.060
¾	14	.987	4	.945	1.058
⅞	16	.989	4½	.967	1.034
1	18	.990	5	.950	1 053
1⅛	20	.991	5½	.951	1.051
1¼	22	.992	6	.953	1.049
			Average,	.949	1.053

In the case of heavy drums wound with large wire rope or heavy chain, it is sometimes desirable to take into account the weight W, in which case the formula should be used.

Gearing.

In Fig. 5, let P = the power applied at a radius R_1, to drive a gear of pitch radius R, having n teeth, and meshing with a gear having N teeth, at the pitch line of which there is a resistance to rotation, = Q. Neglecting all wasteful resistances, we have the theoretical force

$$P_1 = \frac{Q\,R}{R_1} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The wasteful resistances to be overcome are the friction between the teeth of the two gears, and the friction of the journal A.

The friction between the teeth is given by Weisbach as

$$Z = \pi\,\phi\,Q\left(\frac{1}{n} + \frac{1}{N}\right)$$

which, assuming the direction of Q to be normal to the common center line of the two gears, becomes

$$Z = \frac{Q}{3}\left(\frac{1}{n} + \frac{1}{N}\right) = \frac{Q}{3\,n} + \frac{Q}{3\,N}$$

which acts through a lever arm R.

In most cases occurring in practice, the forces P and Q are either arranged on opposite sides of a journal bearing, or one force at each end of a shaft next to a journal bearing. It is thus a close approximation to actual conditions to take the weight upon the journals as $W = 2Q$. Then taking into consideration the wasteful resistances, we have the condition of equilibrium,

$$P\,R_1 = Q\,R + \left(\frac{Q}{3\,n} + \frac{Q}{3\,N}\right)R + 2\,Q\,\phi\,r$$

$$P = \frac{Q\left[R\left(1 + \dfrac{1}{3\,n} + \dfrac{1}{3\,N}\right) + 2\,\phi\,r\right]}{R_1} \ldots\ldots (2)$$

The efficiency of the gear and shaft is

$$e = \frac{P_1}{P} = \frac{\dfrac{Q\,R}{R_1}}{\dfrac{Q\left[R\left(1 + \dfrac{1}{3\,n} + \dfrac{1}{3\,N}\right) + 2\,\phi\,r\right]}{R_1}}$$

$$= \frac{R}{R\left(1 + \dfrac{1}{3\,n} + \dfrac{1}{3\,N}\right) + \phi\,d}$$

where d = the diameter of shaft.

As the expression $\left(1 + \dfrac{1}{3\,n} + \dfrac{1}{3\,N}\right)$ increases in value as the number of teeth diminishes, it follows that the number of teeth in the large gear remaining constant, the efficiency of the pinion and shaft is greater as the number of teeth n is greater. A smaller pinion than one of thirteen teeth being little used, $n = 13$ has been taken as the basis of the following table, No. 6. The pitch of the pinion being taken as 1¾ inches, gives the pitch diameter for a pinion of thirteen teeth as 7¼ inches nearly. The diameter of the pinion shaft is taken as 3 inches, and the table gives the efficiency of the pinion and shaft when running in mesh with gears of various numbers of teeth, giving various velocity ratios.

TABLE NO. 6. EFFICIENCY OF GEARS AND SHAFTS,

No. of Teeth in Pinion.	Pitch in inches.	Pitch Diam. of Pinion Approx.	Diam. of Pinion Shaft.	$e = \dfrac{R}{R\left(1+\dfrac{1}{3\,n}+\dfrac{1}{3\,N}\right)+d\,\phi}$														
				NUMBER OF TEETH IN GEAR AND VELOCITY RATIO.														
				T	R	T	R	T	R	T	R	T	R	T	R	T	R	
13	1¾	7¼	3	13	1:1	20	1:1½	26	1:2	39	1:3	65	1:5	91	1:7	117	1:9	Average
				.922		.929		.933		.937		.940		.941		.942		.934
Coef. resistance $k = \dfrac{1}{e} =$				1.084		1.076		1.072		1.067		1.064		1.062		1.061		1.070

Efficiency of a Complete Machine.

From the consideration of the efficiency of the several mechanisms which, combined, form a machine, we may by the general formula already given,

$$e = e_1 \times e_2 \times e_3 \times e_4 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots e_n$$

pass to the determination of the efficiency of the complete machine.

Fig. 7 represents the several elementary parts of a crane. The power is applied at the crank F upon the crankshaft A, and a pinion a upon this shaft meshes into a gear b upon the intermediate shaft B. A pinion b_1 upon this shaft meshes with a gear c upon the drum shaft C. Thus the power is transmitted to the drum E upon which the rope which passes to the tackle D is wound, and thus the load Q is raised. The speed reduction of the two gears is shown in the figure as 1 : 4 in each case, and the tackle is shown as having four runs of rope. This completes the elementary crane. There are many devices such as friction pawls, ratchet wheels, band brakes, etc., which are applied to cranes for various purposes, but these do not as a rule affect the efficiency of the machine.

In the following consideration of the efficiency of the complete machine the average values given in the preceding tables will be used as follows:

e_1 = the efficiency of pinion a and shaft A (table No. 6) = .934
e_2 = the efficiency of pinion b and shaft B (table No. 6) = .934
e_3 = the efficiency of drum E and shaft C (table No. 5) = .949
e_4 = the efficiency of tackle D, 4 ropes (table No. 4) = .875.
e = the efficiency of the complete machine = $e_1 \times e_2 \times e_3 \times e_4$
then $e = .934 \times .934 \times .949 \times .875 = .723$.

While on account of the small force available for operation, the hand crane is usually double geared, the steam crane, being operated by much greater force, is often single-geared. Thus, should a steam crane be applied to the elementary crane of Fig. 7, the shaft *A*, pinion *a*, and gear *b* would be omitted, and shaft *B* would become the engine shaft. The mechanical efficiency of small, simple slide valve engines is given by several authorities as 85 per cent. to 90 per cent. Assuming the smaller of these two values, we have

e_1 = the efficiency of the engine................ .850
e_2 = the efficiency of the pinion and gear........ .934
e_3 = the efficiency of the drum and shaft........ .949
e_4 = the efficiency of the tackle................ .875
$e = .850 \times .934 \times .949 \times .875 = .656.$

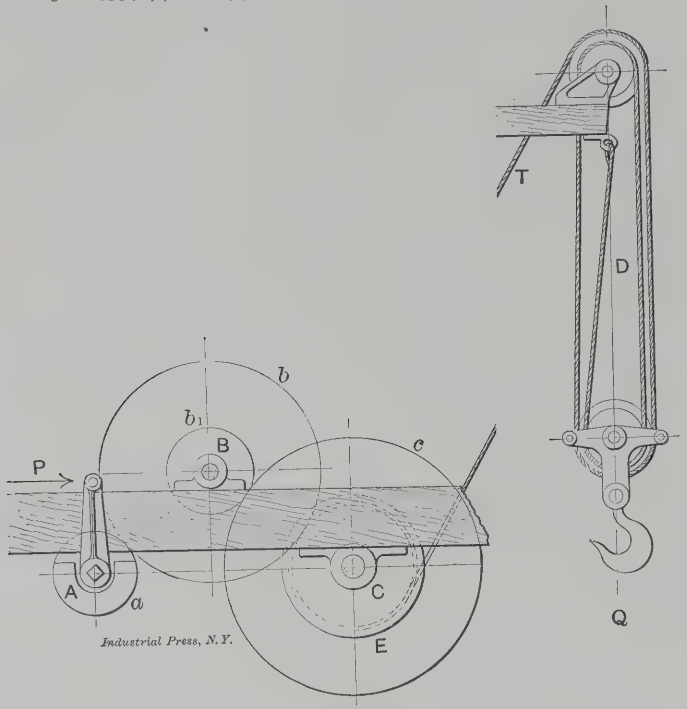


Fig. 7.

Taking the above value obtained for the hand crane as a basis, we have the coefficient of resistance for the complete crane, $k = \frac{1}{e} = \frac{1}{.72} = 1.38$ Example: One man can exert a force of about 30 pounds upon a crank handle. If four men are working at a crank *F*, 16 inches long, the ratio of the gears *a*—*b* and *b*—*c* is 1 to 4 in each case, and the diameter of the drum is 24 inches; the force or pull in the rope wound around the drum is

$$T = \frac{120 \times 16 \times 4 \times 4}{12} = 2560 \text{ pounds.}$$

Fig. 7 shows the crane as having four runs of rope, which gives the load

$$Q = 2{,}560 \times 4 = 10{,}240 \text{ pounds.}$$

The actual load *L* that can be raised by four men working this crane would be, assuming the efficiency as 72 per cent.,

$$L = 10{,}240 \times .72 = 7{,}372 \text{ pounds, or about } 3\tfrac{1}{2} \text{ tons.}$$

Conversely: A load of 3½ tons is to be raised by such a crane. We have the force or pull in the rope

$$T = \frac{7000}{4} = 1750 \text{ pounds.}$$

Then the power required at *P* is

$$P = \frac{1750 \times 12}{4 \times 4 \times 16} = 82 \text{ pounds nearly.}$$

The coefficient of resistance is 1.38, and we have the actual force required on the crank *F* as

$$P = 82 \times 1.38 = 113 \text{ pounds nearly,}$$

which would be fair work for four men.

* * *

High temperatures are now easily measured with the electric incandescent lamp. The lamp, in line with the furnace, backing or other hot object, is viewed through a small telescope, when the filament disappears on reaching the temperature of the background. An ammeter shows the amount of current feeding the lamp, while a special scale indicates very accurately temperatures up to 3,600 degrees Fahr.

STEEL VS. CONCRETE FOR FLOORS.

In a contribution to *Insurance Engineering*, Frank B. Abbott contends that the steel floor beams used universally in the modern steel buildings are a useless and extravagant appendage. Fire and corrosion are the enemies of steel, and it follows that, when the requirements of strength and durability have been met the less steel there is in a building the less danger there will be from these enemies, and the safer the building. Also, the less steel required in a building, the more nearly fireproof the building will be, provided a better substitute can be found. He holds that long floor arches between the steel floor girders cost less per square foot than the short arches usually built between the steel floor beams spaced near together, and supported by the girders. The floor beams constitute about one-half the total steel tonnage of the average fireproof building; and yet they have been a necessary part of the framework, for arches of concrete and brick, having greater spans than the length of the average floor beam, and carrying greater loads, have been in use a thousand years. The average fireproof building, taking this country at large, contains more than 1,500 tons of structural steel, but, assuming a basis of 1,500 tons, the cost, at $60 per ton erected in the building (the present cost is about $70) is $90,000, and as about one-half of this tonnage is in the floor beams, there has been expended, therefore, not less than $45,000 uselessly—$45,000 paid out in the construction of the building without adding one dollar to its value, or strength, or earning power. In a thousand such buildings, and there are many more than this in the United States, we have the enormous sum of forty-five million dollars thrown away, except as it has helped to swell the profits of the "steel trust," and when we eliminate one-half the structural steel from a building we eliminate one-half of the risk from fire and corrosion—an important matter, viewed from an insurance standpoint. How much further we may go in this process of elimination remains to be seen. There is less need, however, for further elimination, because the steel column and the girder perform necessary structural functions, while the beams have always been superfluous.

Having dispensed with the beams, it is best that we determine at once, before paying any more premiums to ignorance or cupidity, what are the best materials and methods of construction for the floor arches which replace them. The requirements of these arches are that they shall be fire-resisting, have the requisite strength, and be of such nature and construction as to prevent the corrosion of the steel girders. As to the first two requirements, bricks, terra-cotta or concrete will answer equally well; as to the third requirement, only one, i. e., concrete, will do the work. If the girders are well grouted with cement or lime grout, however, the other materials will answer; but in practice that material which requires the least outlay in time and money, after meeting the above requirements, will be the one used.

Cement affords absolute protection against corrosion to steel work, when properly applied. Structural steel need not be pickled, or put under a sand blast, or treated in any other expensive manner, nor should it be painted, before being concreted in. It is only necessary that it be thoroughly brushed with wire brushes, so as to remove all dirt and loose scales, for cement has a strong affinity for steel and iron. Any incipient corrosion that may be set up during the construction of the building will be so slight that it may be disregarded, and as soon as the concrete sets corrosion is arrested, and after the concrete hardens it can be removed only by the use of cold chisel and hammer.

As to the strength of concrete the writer recently witnessed a test of a concrete arch 5½ feet wide and 16 feet span made as follows: Natural cement one part, lake sand one part, cinders four parts, and in the concrete were imbedded three 2-inch by 2-inch steel T-bars, curved to the radius of the arch, and supported by the lower flanges of the girders. The arch was 20 inches deep at girders and 8 inches at crown, and had a rise, therefore, of 12 inches. After standing 30 days the arch was loaded to the extent of 900 pounds per square foot, and sustained this load for 30 days without visible deflection.

SLOW-BURNING CONSTRUCTION.

FOR SHOPS AND MANUFACTURING BUILDINGS.

In one of the recent reports of the Insurance Experiment Station, Boston, Mass., are several studies of what is known as the "Slow Burning" or "Mill" type of construction of buildings, which has proven so satisfactory for textile mills and many other branches of manufacturing, including machine work. There is no type of building which is on the whole better adapted for machine shops of medium size, especially when the building is to have several floors, than this type, in which wooden columns and floor beams are employed instead of the usual steel columns and beams generally found in modern shop buildings.

It may be said that the theory of the slow-burning or mill type of construction is that heavy timbers and solid plank flooring will withstand the ravages of fire for hours, where floors supported by steel columns and beams might sag or even fall, through the bending of the steel members, due to the intense heat of the flame. Mill buildings generally have brick walls, supporting massive floor timbers, widely spaced, with thick plank floors, tongued and grooved, covered with a layer of hard wood flooring; and large square wooden columns. If there are no openings in such floors, for belts, stairs, elevators, pipes, etc., by which fire can get a foot-hold, they will effectually prevent the spread of flame either up or down, and will confine the fire between floors for hours without burning through. The large timbers, also, when once charred, do not seem to burn to any great extent, even under the most severe conditions, and will remain intact longer than even granite columns under intense heat.

The following concise statement of what Mill Construction is and what it is not, as well as the practical information relating to the design of such buildings is taken from the pamphlet referred to containing the report of the Insurance Experiment Station and will form a valuable supplement to the articles on shop construction now running.

What Mill Construction Is.

1. Mill construction consists in so disposing the timber and plank in heavy solid masses as to expose the least number of corners or ignitable projections to fire, to the end also that when fire occurs it may be most readily reached by water from sprinklers or hose.

2. It consists in separating every floor from every other floor by incombustible stops—by automatic hatchways, by incasing stairways either in brick or other incombustible partitions—so that a fire shall be retarded in passing from floor to floor to the utmost that is consistent with the use of wood or any material in construction that is not absolutely fireproof.

3. It consists in guarding the ceilings over all specially hazardous stock or processes with fire-retardant material such as plastering laid on wire-lath or expanded metal or upon wooden dovetailed-lath, following the lines of the ceiling and of the timbers without any interspaces between the plastering and the wood; or else in protecting ceilings over hazardous places with asbestos air cell board, sheet metal, sackett wall board or other fire-retardant.

4. It consists not only in so constructing the mill, workshop or warehouse that fire shall pass as slowly as possible from one part of the building to another, but also in providing all suitable safeguards against fire.

What Mill Construction is Not.

1. Mill construction does *not* consist in disposing a given quantity of materials so that the whole interior of a building becomes a series of wooden cells; being pervaded with concealed spaces, either directly connected each with the other or by cracks through which fire may freely pass where it cannot be reached by water.

2. It does *not* consist in an open-timber construction of floors and roof resembling mill construction, but of light and insufficient size in timbers and thin planks, without fire-stops or fire-guards from floor to floor.

3. It does *not* consist in connecting floor with floor by combustible wooden stairways incased in wood less than two inches thick.

4. It does *not* consist in putting in very numerous divisions or partitions of light wood.

5. It does *not* consist in sheathing brick walls with wood, especially when the wood is set off from the wall by furring, even if there are stops behind the furring.

6. It does *not* consist in permitting the use of varnish upon woodwork over which a fire will pass rapidly.

7. It does *not* consist in leaving windows exposed to adjacent buildings unguarded by fire shutters or wired glass.

8. It is dangerous to paint, varnish, fill or incase heavy timbers and thick plank as they are customarily delivered, lest what is called dry-rot should be caused for lack of ventilation or opportunity to season.

9. It does *not* consist in leaving even the best constructed building in which dangerous occupations are followed without automatic sprinklers, and without a complete and adequate equipment of pumps, pipes, and hydrants.

10. It does *not* consist in using any more wood in finishing the building after the floors and roof are laid than is absolutely necessary, there being now many safe methods available at low cost for finishing walls and constructing partitions with slow-burning or incombustible material.

It follows that if plastering is to be put upon a ceiling following the line of the under side of the floor and the timber, it should be plain lime mortar plastering, which is sufficiently porous to permit seasoning. Adding a skim coat of lime putty is hazardous, especially if the top floor is laid upon resin-sized or asphalt paper. This rule applies to almost all timber as now delivered.

Standard Type for Building.

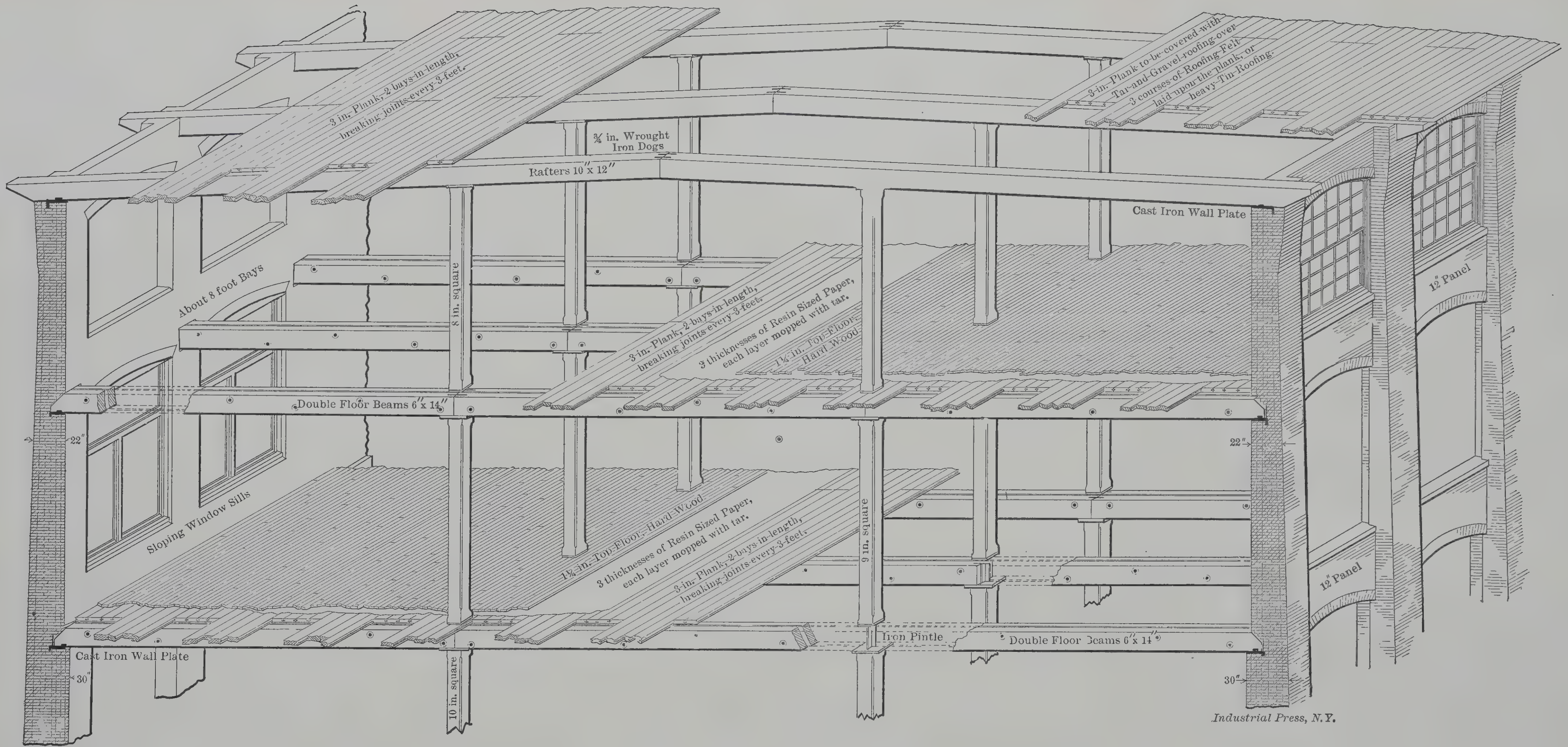
The illustration on page 414 shows the section of a mill of the customary or standard type. Two floors are pictured, showing a section of the wall, cut off at pilasters between the windows, the thickness of panels to be adjusted to the thickness designated in the drawing. If additional stories are required, the walls may be increased in thickness according to the number of stories added, after a computation of the loads which a standard factory may be called upon to sustain.

The window at the left represents what is known as the English type of window—the lower sash being either fixed or swinging on hinges, the upper sash mounted like a transom, and opening inward for ventilation. Attention is called to the fine ribbed glass which is translucent but not transparent, diffusing the light, making no hard shadows, and preventing the glare of sunlight to such an extent that window shades are seldom required.

It is assumed that no well-informed mill owner, engineer or builder would fail to construct the stairways in towers or sections of the building, cut off by incombustible walls from all the rooms of the factory, the entrances to each room being guarded with standard fire-doors. In modern practice, all belts or ropes which may be used for the transmission of power to the various rooms, are placed in incombustible, vertical belt chambers from which the power is transmitted by shafts through the walls into the several rooms of the factory. There should be no unprotected or unguarded openings in the inner walls of this belt chamber.

Elevator shafts and belt towers or chambers should be guarded by fire-doors and covered overhead by skylights, glazed with thin glass, protected underneath with wire netting. Hatchways outside of fire-proof shafts should be well guarded by automatic or self-closing hatches, both to stop the passage of fire and to assure safety to persons. The most important feature in what is called slow-burning construction is to make each and every floor continuous, avoiding belt holes and open ways to the utmost possible extent, so that a fire originating in any one room may be confined to that room or story, if possible.

Timbers, unless known to be absolutely and fully seasoned, should not be incased in any kind of air-proof plastering, nor should they be painted with oil paints—whitewash, kalsomine and water paints may be used, as they are porous. Timbers or plank may also be covered in with common lime mortar laid on wire lathing, provided no skim coat of lime putty is added. Ordinary plastering unskimmed is sufficiently porous to permit seasoning. As a rule, timbers may be left unpro-


3 in. Plank, 2 bays in length, breaking joints every 3 feet.
¾ in. Wrought Iron Dogs
Rafters 10″ x 12″
3 in. Plank to be covered with Tar and Gravel roofing over 3 courses of Roofing Felt laid upon the plank, or heavy Tin Roofing.
Cast Iron Wall Plate
About 8 foot Bays
8 in. square
3 in. Plank, 2 bays in length, breaking joints every 3 feet.
3 thicknesses of Resin Sized Paper, each layer mopped with tar.
1¼ in. Top Floor, Hard Wood
12″ Panel
Double Floor Beams 6″ x 14″
22″
22″
Sloping Window Sills
1¼ in. Top Floor, Hard Wood
3 thicknesses of Resin Sized Paper, each layer mopped with tar.
3 in. Plank, 2 bays in length, breaking joints every 3 feet.
9 in. square
12″ Panel
Iron Pintle
Double Floor Beams 6″ x 14″
Cast Iron Wall Plate
30″
10 in. square
30″

Industrial Press, N.Y.

Fig. 1. Slow-burning or Mill Type of Building for Manufacturing Purposes.

tected, except in very dangerous places, since any fire which will seriously impair and destroy a heavy timber will already have done its work upon other parts of the structure.

In many instances it may be preferable to substitute compound beams for single timbers, made by securing two or more beams or thick planks side by side, it being often easier to obtain well seasoned lumber in smaller dimensions; such compound beams, of which the parts may be slightly separated by spaces for ventilation when put together, are less subject to decay.

Buildings in which there is excessive vibration through the motion of machinery can be made more rigid and more capable of resisting the vibration by laying the top floor across the plank and parallel to the beams, nails being driven in diagonal rows. This may brace the floor as firmly as diagonal boarding, and it avoids the increased expense in construction and repairs which ensues from the adoption of that method.

The edges of the floor plank should be kept clear of the faces of the brick walls by about half an inch, in order to obviate the danger of cracking the walls, which sometimes occurs from the swelling of the plank when laid close against them. These cracks must be covered by strips or battens both above and below.

To protect the contents of floors below, three thicknesses of tarred paper should be placed between the floor plank and top floor, each layer to be mopped with tar, asphalt or similar material, care being taken to break all joints.

Basement floors can be laid solid upon the natural soil if it is dry, or upon rock or cinder filling, by covering either with a suitable layer of coal-tar concrete. Upon this concrete place an under floor of two-inch seasoned plank. Then lay the top flooring across the plank and nail in the usual manner. Sills under the plank are not thought to be necessary to the preservation of the floor. If extra support is required to sustain machinery more firmly than it can be upon a plank and board floor, independent foundations of masonry are generally preferred. Cement concretes may absorb moisture and promote the decay of timber or plank laid upon them.

In view of the difficulties which have frequently occurred in preserving basement floors of the ordinary timber construction, for lack of suitable ventilation underneath, and also in view of the rapid decay of timber and plank floors in bleacheries, dye works, print works and the like, where they quickly become saturated with moisture, artificial stone floors are being laid in many of the modern plants.

If the building is to be heated by conveying steam through pipes, such pipes should be hung overhead. If the modern method, which is probably the best method, of conveying the heat through ducts in the plastered walls should be adopted, provision will be made thereto in the construction of the mill wall.

The carrying off from the walls of about one-half a roof corresponding to this plan, in a hurricane, is an instance which calls attention to the necessity of tying, binding or bolting the timbers of the roof to the walls of the mill in a safe and suitable manner. This is the common practice, but the necessity is sometimes overlooked.

Single Story Machine Shop.

For workshops on cheap, level land, especially where the stock is heavy, one-story buildings have proved to be more economical in cost of floor area, supervision, moving stock in process of manufacture, and repairs to machinery—many kinds of which can be run at greater speeds than when in high buildings.

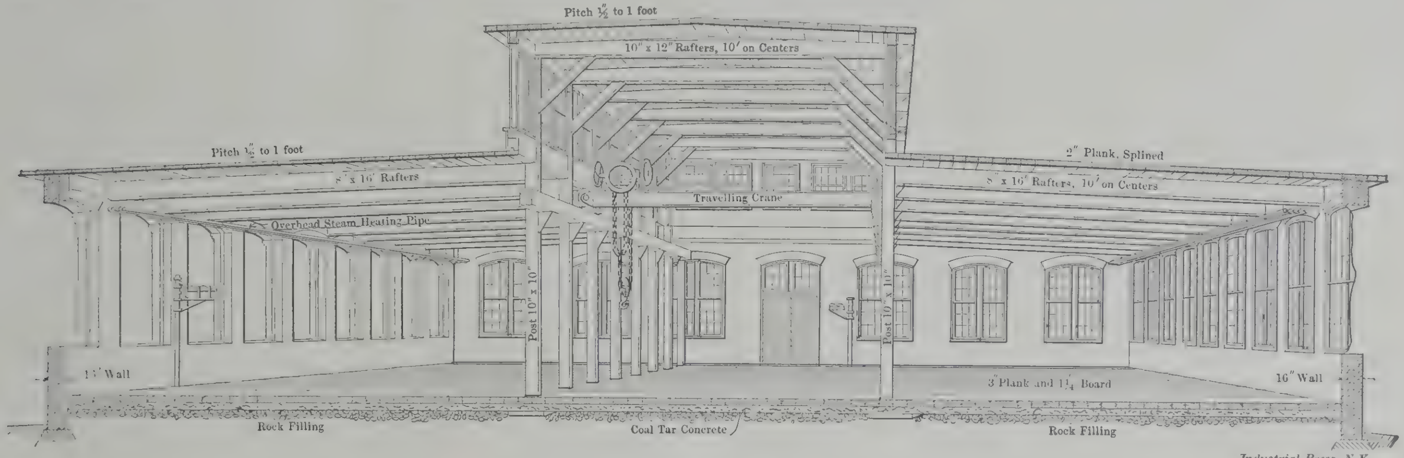


Fig. 2. Single Story Machine Shop.

Such buildings are readily warmed and ventilated, and heavy plank roofs are free from condensation in cold weather; the large window area reduces the hours of artificial illumination. Forced circulation of heated air is a very desirable method of heating a mill, being economical as to maintenance and repairs, and thoroughly under control. Overhead steam pipes are very satisfactory, if used in the ratio of one foot of 1¼-inch pipe to 70 cubic feet of air.

Floors over an air space or on cement are subject to dry-rot. Asphalt or coal-tar concrete is softened by oil, and the dust will wear machinery, unless covered by flooring. Floors made by laying sleepers on six inches of pebbles, tarred when hot, then two inches tarred sand flush to top of sleepers and covered by double flooring, have remained sound since 1865; but double flooring at right angles can be laid on the concrete without the use of sleepers, and nailed together. It is usually preferable to secure nailing strips to stakes four feet apart each way and driven to grade, concrete flush to top of strips, and lay single 1½-inch flooring.

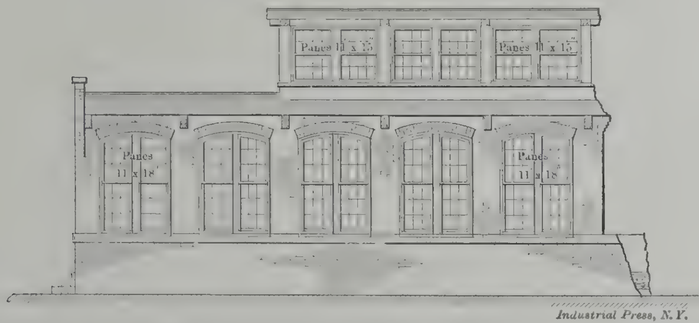


Fig. 3. Exterior of Single Story Structure.

Piers reach to roof timbers, and light walls to window sills are finished with slope on inside. To increase the window area over that shown in the elevation, the brick piers between the windows may be narrowed and made thicker so as to give the requisite strength, leaving more space for light. Large windows are placed high, and the sashes separated by a mullion. Lower sashes should be stationary and glazed with ribbed glass, with transom sash or window ventilators above. If the light is too strong, apply to glass white zinc and turpentine. Monitors may well be glazed with ribbed glass.

Wooden mill columns, Southern pine or oak, safely sustain loads of 600 pounds per square inch; a square column is stronger than a round one of the same diameter. They should have a 1½-inch core bored from end to end, and two half-inch holes through the column near to each end. The columns should be securely held at each end, the base resting on iron plates projecting above the floor level, and the caps at the top bolted to the roof beams.

Double or solid timbers of Southern pine support the roof plank, and the ends pass through the wall, and are finished as brackets to the cornice: or another plan often adopted is to make a projecting brick cornice covering the ends of the roof timbers, thus avoiding the exposure to an outside fire. The beams are anchored to plates in the walls by means of tongues which project into grooves across the lower side of the beams. Beams should not be painted or varnished until thoroughly seasoned.

The roof plank should be two bays in length, breaking joints every three feet. There is no need of gutters, but a concrete walk at the ground level, sloping toward drains, will take the water from the roof. Do not drive nails upward into the roof plank, as moisture will condense and drop from the heads.

Monitors must be of solid construction.

The roof should be tied by binding or bolting the timbers of the roof to the walls of the mill in a safe and suitable manner. This is the common practice, but the necessity is sometimes overlooked. The saw-tooth roof is taking the place of the monitor roof in many buildings, and it requires, in each case, the service of a competent engineer and constructor to plan the roof so as to meet special conditions, and to supervise the work.

* * *

The lightest known wood is said to be the so-called corkwood tree, which in the swamps of Southeastern Missouri reaches a height of 15 or 20 feet and a diameter of two to five inches, and is found in occasional small species in Florida and Arkansas. Its specific gravity is .207, while that of its roots is only .151. The wood, though spongy, is far tougher than cork. The specific gravity of cork—which is the outer bark of a kind of oak—is .240, while that of most woods is between. .400 and .800, and that of the heaviest woods is greater than of water, that of American ebony, for example, being 1.331.

* * *

In England, the Sunderland Town Council has decided to try the experiment of supplying electricity for the lighting of the workmen's dwellings owned by the municipality on the penny-in-the-slot principle. The corporation propose to supply an 8-candle power light which will last five and one-fifth hours for one penny.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The report of the Commissioner of Patents for the calendar year 1902 shows a total of 49,490 applications for patents, including designs, and that 27,776 patents, including designs, were issued. In addition there were 110 patents reissued, 2,006 trade marks registered, and 767 labels and 158 prints registered. During the year, 23,331 patents expired, 4,471 applications allowed were forfeited because of non-payment of fees, and 9,284 allowed applications are still awaiting final fees. The excess of receipts over expenditures was $159,514.

The American Foundrymen's Association has recently organized a "Metallurgical Section." This was undertaken in response to an increasing demand for an organization to harmonize methods of analysis of iron. It is designed to increase the use of metallurgy in foundry and furnace work, and to serve as a board of exchange, as it were, for those interested in the study of iron as a specialty. All furnaces, foundries, individual chemists and independent laboratories who would be interested to receive more particulars concerning this Section are requested to send their names to the Secretary, Herbert E. Field, at Box 104, Ansonia, Conn.

Plans for the fourth bridge across East River, New York, have been completed and accepted by the city engineers. The design is for a suspension bridge, involving several novel ideas for a structure of this magnitude. The central span will be 1,475 feet, with two side spans, each 725 feet long. Total width 96 feet. In place of cables immense eyebar chains are to be employed. If possible these will be of special steel having an elastic limit of 50,000 pounds per square inch. The cross-sectional area of these chains will have to be about double the area of cables to sustain the same load, including their own weight, but they will have the advantage of accessibility for examination and repair, while the inner strands of a cable are of course entirely closed from view. The bridge towers embrace the most novel feature of the structure. Each tower is really a bent and consists of four vertical posts, made up of structural steel. Each is supported on a pin at the bottom and the chains are rigidly connected to pins at the top, instead of passing over shoes in the usual manner. There will thus be no slipping or rubbing due to expansion and contraction of the cables, as this is to be compensated for entirely by the swinging of the towers.

One of the last bills to be passed and become a law during the last session of Congress was one relating to patents and trademarks. The bill was for the purpose of completing the compact between the United States and the more important foreign nations with regard to international protection of industrial property, according to terms of an agreement entered into at a convention in Belgium over two years ago. Without the passage of this act the United States could not have enjoyed the privilege of the other terms of the treaty and hence the bill is of greater importance than the mere text of its provisions would indicate. The general result of the bill, as explained by the *Scientific American*, will be not only to extend the time in which foreigners may file their applications in the United States patent office, but also provides that when an application is filed in the United States by any person who has previously filed an application for a patent in a foreign country which by treaty, convention, or law, affords similar privileges to citizens of the United States, the application in the United States shall have the same force and effect as though it were filed in this country on the date on which the application for a patent for the same invention was first filed in such foreign country. The effect of this amendment will be far-reaching, as for instance in interference cases, where the foreign inventor may claim the date of the filing of his first foreign application, for all purposes, as his date of filing in the United States patent office, although the actual filing of the application papers in the United States patent office was not made until nearly a year after such date. Under the amendment, foreign inventors will be obliged to file their applications for design patents within four months of the filing of their first foreign application.

The plan and scope of the Carnegie Institution at Washington, D. C., endowed by Andrew Carnegie, for scientific investigation and research, was outlined in the February issue of *Science*. The work of this institution is to be conducted by the distribution of funds for the assistance of individuals, and in some cases of societies or institutions qualified by training or equipment to carry on investigations, and it is proposed to make grants of money for this purpose, mainly; though a certain amount will be available for the purchase of apparatus, instruments, books, etc., to aid persons of marked ability in original work, such apparatus or materials remaining the property of the Carnegie Institution. It is not proposed to equip the institution with buildings for research such as is done in the engineering laboratories of our technical schools or to attempt courses of instruction or to otherwise conflict with organizations already doing good work in the field of engineering or science. Although efforts will be made to cooperate with all such agencies established for the advancement of knowledge, care will be taken to avoid interference or rivalry. For example, if medical research is provided for by other agencies, as it appears to be, the Carnegie Institution will not enter that field. Sites or buildings for other institutions will not be provided nor will assistance be rendered to students in the early stages of their studies. All work for which grants are made will be subject to the approval, or be placed under the direction of the committee in charge and in this way it is hoped to avoid duplication in tests or investigation; and a thorough plan of procedure will be mapped out to insure systematic work. For the present year $200,000 are at the disposal of the committees for rendering assistance in the various fields to be covered, and $40,000 to cover the expenses of publishing the results.

On March 3 the Brush patent on storage battery electrodes expired. This is one of the most remarkable patents in the field of electrical engineering and its termination will enable new manufacturers of storage batteries to come into the field, and many of the present manufacturers to improve their product. The patent has formed the basis of extended litigation, but its claims were broad enough to stand. In commenting upon this patent the *Electrical World* publishes the following interesting paragraph:

It is now almost twenty-two years since Sir William Thompson sensationally introduced the storage battery to the world by remarking dramatically at a scientific gathering that a small box he held in his hand contained one million foot-pounds of stored energy. The statement caught the fancy of the newspapers of the world, and for a long period the storage battery monopolized attention to the exclusion of other current electrical developments. Highly capitalized companies were everywhere formed to exploit the new marvel, inventors the world over turned attention to its improvement, and patent offices were overwhelmed with applications based upon their work. Four years later the electrical public was startled by the issue of a patent to Charles F. Brush, which not only covered the whole previous art, excluding Planté cells, but also any improvements to the composite plate that might be made during its life of seventeen years—which only ended last week. Though the very principle of the storage battery as developed from the beginning of last century involved a metallic structure, the Brush patent of March 3, 1886, covered absolutely the use of a metallic support in connection with any improvement offered, which claim practically closed the art to all except the owners of the patent, and rendered subsidiary to it the many hundreds of patents which irrepressible inventors nevertheless insisted upon taking out during its life.

PORTABLE UNIVERSAL MACHINE TOOL.

Le Genie Civil.

It is generally acknowledged to be frequently of a very great advantage in the execution of heavy work to be able to take the tool to the work rather than the work to the tool. Many devices have been brought out for that purpose, and among them is the one shown in the accompanying illustration and designed by Emile Capitaine & Co., Frankfort-on-Main, Germany. The apparatus, as shown in Figs. 1 and 2, consists of a hollow spindle carrying the tool, which is rotated by a small electric motor, acting through a flexible shaft and a worm gearing, the latter being integral with the machine. The longitudinal movement of the spindle is effected by means of a nut turned by a hand wheel, and which engages in a thread cut upon the tube holding the spindle in line. The whole is fitted with a stirrup so connected that it can be suspended and balanced in any position best adapted for the execution of the work in hand.

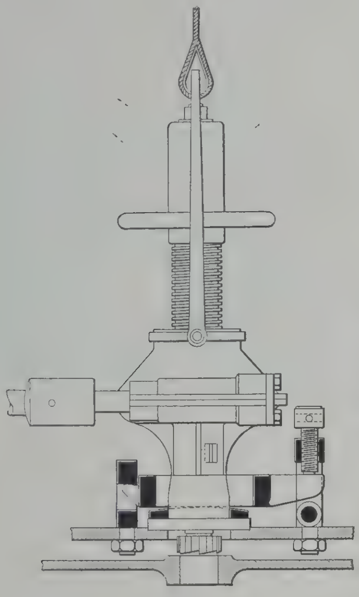
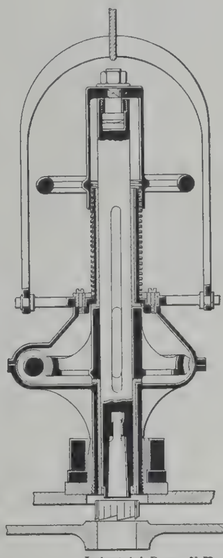


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

In the application of this device there are a number of combinations of supports that have been designed by which it has been possible to so hold the machine that it can execute even complicated work with a great degree of precision and that, too, without being obliged to change the position of the parts during the operation. It can be used for boring, drilling, reaming, facing off cylinders, cutting out ports and other work of a similar character. In adjustment it is only necessary to hold the frame rigidly in position, which can be done by bolting or clamping, as shown in Fig. 1, and the tube then holds the spindle in line.—G. L. F.

REAL PROFIT-SHARING AND ITS RESULTS.

The Independent, March 12, 1903, p. 619.

The Rev. George L. McNutt, who has spent the past four years as a working man, investigating the conditions of the laborer from his own standpoint, gives an account of the profit sharing plan that is in operation at the pump and windmill manufactory of A. S. Baker & Co., at Evansville, Wisconsin. This company was founded in 1873, but owing to divided management was operated unsuccessfully for a number of years. It was then placed under the absolute management of Mr. Baker, and in 1891 the first dividend was declared. In 1897 Mr. Baker's son, J. S. Baker, was made a director of the company. He had been a student at the University of Wisconsin, and was imbued with the justice and necessity of democratizing industry. After two years of careful study he devised a plan for profit sharing, which was adopted by the company in February, 1899.

As a beginning, each man who had been in the company's employ during the past year was given a bonus of 10 per cent. on his wages. Meanwhile the business of the company was enlarged by increasing the capital stock to $300,000; $200,000 of this was preferred stock, fully paid up, and $100,000 to be issued in profit sharing between labor and capital in proportion to the earnings of each, the earnings of capital being arbitrarily fixed at 5 per cent. on preferred stock, and the earnings of labor being the amount earned by each employee on day wages or salaries during each year.

Just here is the genius and value of the plan as devised and carried through by the Baker Company. Instead of treating, as is usual, a dollar of preferred stock and a dollar of wages as of equal standing in the division of profits, so that if there is a net profit of 5 per cent., a man with a salary of $500 a year receives $25; according to Rule II. of the By-Laws of this Baker Company, the net profits shall be divided between the preferred stock and labor in proportion to the earning capacity of each. This, in the hands of a shrewd lawyer, might be interpreted in various ways. Interpreted and carried out by the Baker Company, it means this: The money paid to stockholders as dividends and the money to labor as wages is in each case treated as for practical purposes earnings on capital. The capital of the stockholder is the total of money invested, the capital of the laborer is the total of his strength, his character, his skill, these three, muscle, brain, soul or self. Money capital is paid a yearly dividend of 5 per cent., man capital is paid the current wage of a given trade. Money capital and man capital being equals in the eye of the law of the company, it is a simple problem in percentage to reckon up the man capital of a laborer from his yearly wage. Divide by 5, multiply by 100. A $500 a year common laborer is a $10,000 man. The $2 a day steel company employee earning $600 a year would in the Baker Company in effect be a $12,000 man. Last year he would have received his $600 wages and his share as a capitalized man of the profits. This last was actually 82 7-10 per cent., or $496.20 to each $2 a day man who had been two years in their employ. The contrast between a year's profits of $496.20 earned and received and a $5 or $15 bonus bestowed is striking

Money capital draws its dividends once a year, the man capital once a week. The year's dividends to money having been paid, 10 per cent. of the remaining earnings is put aside into a rainy day sinking fund. The remainder is now ready for division between the two capitalists, the money and the man, "according to the earning capacity of each." The $20,000 stockholder, who for his ducats has received a $1,000 dividend, and the $20,000 mechanic, who for his skill, strength and character has received a $1,000 dividend, wages we say, meet now to divide the profits dollar for dollar on the earnings—that is, the capital of each—not a dollar of stock or money capital against a dollar of the earnings of man capital. One can see the virility of such an evolutionary idea.

The peculiar and beautiful point of it all is the lifting up of a man from the plane of a mere seller of muscle to the position of a capitalist. Business having been very flush the last four years, profits have been correspondingly large. After the 5 per cent. dividend on preferred stock and all wages and salaries were paid in January, 1900, 10 per cent. of the remaining surplus was paid into a sinking fund, and the remainder became subject to profit sharing between labor and capital, increasing the earnings of labor and capital that year 60.3169 per cent. In 1901, enlarging the sinking fund by 10 per cent. of the net earnings, the earnings on the common stock and profit sharing of labor were increased 82 7-10 per cent.

And what are the results on the community. One of the immediate and most substantial results is the building of homes by the men. At any time a man wishes to build a home the company will treat his common stock as in effect so much building loan association stock and loan money, at a reasonable interest. And one can find many beautiful cottages, which are profit sharing cottages, where it is possible for a man to "make a happy fireside clime for weans and wife." In the high school one feels the effects. The attendance at the high school of this town where labor has been capitalized is greater than that of many other near-by Wisconsin towns of double the population. There is no stern economic necessity that drives the boy into the shop and the girl to the office or store. In line with this general policy boys in school are allowed to work on Saturday, earning $2 or $3 a day, and to work during the summer. The town has no open saloon. There are no evidences of pauperism. The wages paid are the current wage of the State for the work that is done. The general addition to the earnings of these Wisconsin men by the company adds to their standard of living a sum which is a tremendous gain to any one whose standard of living has been scaled to an average wage. There is a clean, straightforward, businesslike, well-kept look to the town. These are some results of real profit sharing, where the shop reacts upon the school, the home and the church.

HERRINGBONE GEARING WITH CUT TEETH.

La Construction Mecanique Internationale, January 30, 1903.

Toothed gearing is used throughout the entire world in the transmission of power in every kind of machinery. The chief points to be observed in the choice of gearing are: Strength, durability and efficiency. All of these requirements can be fulfilled in the manufacture of gears, only by obtaining a perfect adjustment of the teeth and the total absence of any play; so that the run of the gear will be uniform and smooth and that the friction and wear will be diminished, the jerks avoided, and the efficiency increased. These results are possible only by dividing and cutting the gears automatically by machinery. Cutting teeth in this way affords also the advantage that any faulty condition of the material will at once be detected.

A second important point which theory and practical experience teaches is, that in order to obtain in a gear the minimum loss of power the teeth must not be cut in straight lines, but in a helical direction; in this way only can sliding friction, the chief cause of loss of power and of wear and tear, be reduced. The helical teeth possess also the quality of transmitting motion in a uniform manner without any variation of the impulse received by the driven gear, and for this reason the helical toothed wheels are the only ones deserving the name of "wheels of precision" and to be employed in rapidly running sets of gears.

In the straight toothed wheels, the teeth come at once in contact, at the commencement of the locking process, over the full width of the gear with an initial pressure of about its full force. In the helical toothed gears the action is absolutely different; the power coming from the driving on the driven tooth gradually increases from zero to the maximum and diminishes again to zero. Consequently in a straight toothed wheel the whole amount of power acts on the top of the driven tooth and tends to break it with a lever-arm almost equal to the full height of the tooth; in spiral-toothed wheels, on the contrary the force reaches its maximum only after the lever arm has become much smaller; the strength of the spiral teeth is thus much greater than that of the straight teeth. For all of these reasons the spiral toothed wheels can transmit a much larger amount of power than the wheels with the same sized straight teeth and are, moreover, especially suited for very high speeds, such as are required for dynamos, electro-motors, ventilators, water wheels, etc.

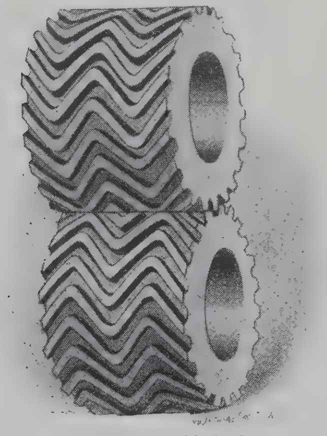


Fig. 1. Machine-cut Helical Gears.

In spite of the great advantages offered by the single spiral-toothed wheels, they are not convenient for the transmission of large quantities of power because they are subject to lateral pressure in the direction of the axis, this lateral pressure being in proportion to the power transmitted, considerable power is thereby lost. To avoid this lateral pressure and its harmful consequences we can divide the wheel in two equal parts; these two parts being cut with spiral teeth of opposite direction. We thus obtain double-spiral, angular or arrow-teeth, in which this lateral pressure cannot occur, for then the two opposite components balance each other. Consequently, in order to obtain in transmission of power the highest efficiency and perfect running, it is necessary that the teeth be carefully cut by machinery and have the shape of a double-spiral or arrow.

This result, which has never been reached by any previously constructed machine, is now possible by the new machines built by Citroen, Hinstin & Co., Essones, France, for cutting cylindrical, conical and hyperbolical gears with double-spiral or arrow teeth. Previously all double-spiral gears have been cast and, although they present great advantages as a consequence of the shape of their teeth, they are far from possessing the advantages of wheels with spiral teeth cut by machinery. The patterns for these teeth cannot be made with accurate spiral surfaces which are prescribed by theory, as molding would be very difficult, and the pattern could not be lifted from the sand. They are, therefore, made with obliquely placed teeth instead of with genuine and exact spiral teeth. The same difficulty in molding necessitates making these teeth with obtuse angles, and likewise the cutting machines heretofore used could cut only teeth of slight inclination, the lateral pressure being too great with teeth of greater inclination. In both cases it is impossible to obtain very smooth running, which is a characteristic of the real spiral wheels.

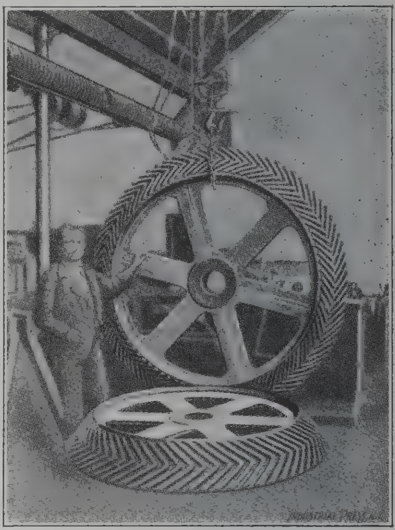


Fig. 2. Machine-cut Helical Bevel Gears.

The new machines obviate all of the above difficulties and permit the accurate and automatic cutting of teeth in a spiral shape; they even render it possible to make spiral gears with multiple arrows (Fig. 1), which would previously have been considered impossible. The spiral teeth are cut with a single stroke and with absolute accuracy. The gears cut by these machines correspond exactly to the theoretical calculations and can be made in any size from the smallest to 80 inches in diameter, for the bevel gears, and 100 inches in diameter for the cylindrical gears.

SUPERHEATED STEAM LOCOMOTIVES, SCHMIDT SYSTEM.

Bulletin of the International Railway Congress, January, 1903.

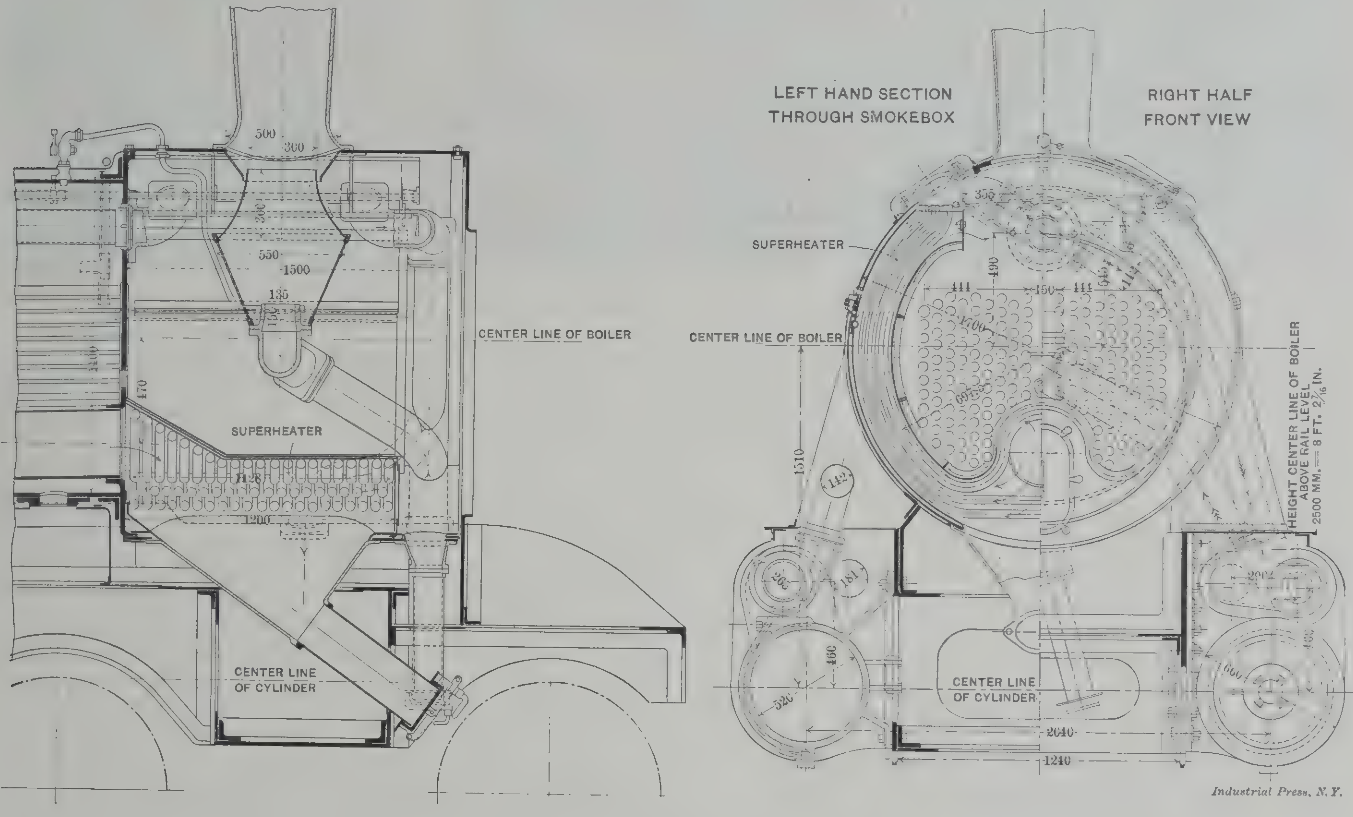
In view of the fact that the Prussian State Railway Administration have ordered 39 superheated steam locomotives, Schmidt system, and that there are already 29 in use on the Prussian railways, making a total of 66 soon to be in use, the subject of superheated steam locomotives assumes a world-wide interest. The trial of superheated steam locomotives on such a large scale, indicates that the Prussian Railway administrators are well satisfied with the economy and practicability of the system. While the system met with much opposition at the start the majority of Prussian locomotive builders are now convinced of its economy and practicability. They believe that its adoption will reduce all locomotives to one type, that is, the simple form opposed to the compound; also that there will not be so many classes required for different kinds of service.

At the November 12, 1901, meeting of the *Verein fur Eisenbahnkunde* Mr. Garbe read a paper on non-compound express locomotives with Schmidt superheaters. An abridged translation of this paper was published in the *Bulletin of the International Railway Congress*, January, 1903, from which we quote in substance:

To William Schmidt, Wilhelmshöhe, near Cassel, is given credit for having successfully applied the principle of superheating to stationary engines, and it was at his instigation that Mr. Garbe, privy councillor for construction, Prussian

State Railways, decided to study the question of the use of superheated steam for locomotives. The results in stationary practice had shown that the power of a steam boiler could be increased 25 per cent. and more if the steam was superheated 180 degrees F. over and above the temperature corresponding to the pressure of saturated steam. The remarkable phenomenon was also observed that, unlike saturated steam, superheated steam was a bad conductor of heat to such a degree that condensation was entirely avoided at ordinary short cut-offs. With saturated steam the loss from condensation often exceeds 30 per cent. It was quickly recognized these features would be of great advantage for locomotives as would allow a reversion to the simple type and still obtain better efficiency than is possible with the compound type, at the same time saving the complication and expense of the extra mechanism.

Mr. Schmidt calls steam superheated when it is heated to a temperature of at least 572 degrees F., that is, to more than 180 degrees F. over and above the temperature of saturated steam at the usual boiler pressures of from 140 to 170 pounds per square inch. Superheated steam at this temperature can be produced with a good apparatus with about 10 per cent. of the heat units developed in the firebox. The advantages are: 1. The initial volume of steam is increased 25 per cent. 2. No condensation takes place in the cylinder even with the shortest cut-offs at which it is possible to work ordinary valve gears consistent with good practice. The Schmidt superheater is located in the smokebox, which has to be made somewhat larger than the diameter of the barrel to accommodate the nests of tubes. It is claimed that the addition of the superheater does not cost $2,000 additional more than a compound engine of the same power when the two types are fairly compared, etc.



Industrial Press, N.Y.

Schmidt Superheater for Locomotives.

The range of the superheated steam engine in the matter of power without impairing the economy was commented on. It was asserted that, provided the degree of superheat was sufficient, superheated steam at a pressure of say, 85 pounds, can give as economical results as saturated steam at 170 pounds. This being the case, it is possible to use cylinders of large diameters and to vary the steam pressure to the load without great loss of efficiency. The area of the piston should be such that with the superheater in action, the full power of the engine will be developed at cut-offs of 25 to 30 per cent. of the stroke. With a steam temperature of 572 degrees F. it is possible to run without condensation in the cylinders with pressures as low as 71 pounds, whereas the normal pressure is 170 pounds. The range is apparent. With large cylinders on saturated steam locomotives, short cut-offs cause condensation; short cylinders necessitate long cut-offs the moment the load exceeds a certain limit. It was shown in this way that the economical limits of power developed by the ordinary simple saturated steam engine, are very narrow, but for the superheated steam engine they are much broader. Hence the designer could adapt a locomotive to a much wider field of operation and make it possible for a railroad to do away with many of the locomotive classes now found absolutely necessary in economical railway operation.

Let d be the diameter of the cylinder, l length of stroke, D the diameter of the driving wheels, all in inches, and T the adhesion weight in short tons, then the dimensions of superheated steam engines, are so proportioned that,

$$\frac{d^2\,l}{D \times T} = \text{from } 3.64 \text{ to } 3.78$$

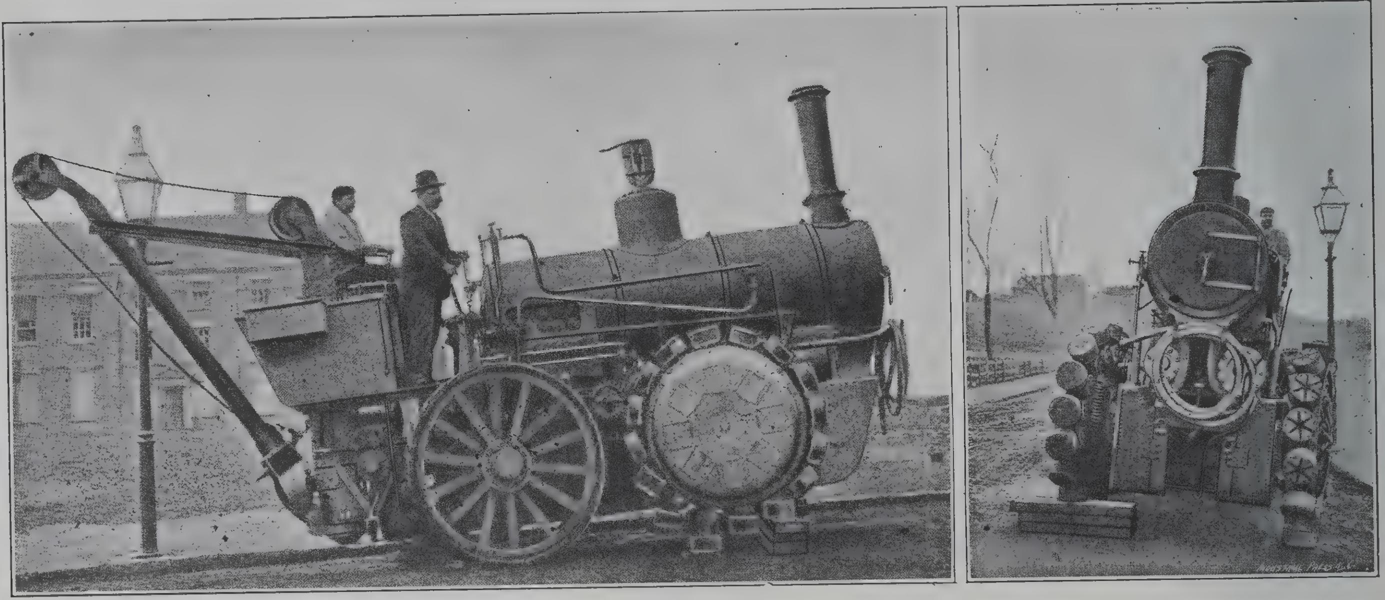
The paper is accompanied with details of construction and performance sheets that should be of considerable value to those interested in the subject. In regard to the details it may be mentioned in this connection that after many experiments it was found that a simple three-ring piston of the so-called Swedish type, gave the best results. Finally the author announced that he had in collaboration with Mr. Schmidt, worked out the plans for four different types of superheated steam engines, that would be able to deal with every kind of traffic on the Prussian State Railways, which may be taken as an indication of the practical value of the innovation so far as reducing the number of locomotive classes.

A NOVEL TRACTION ENGINE.

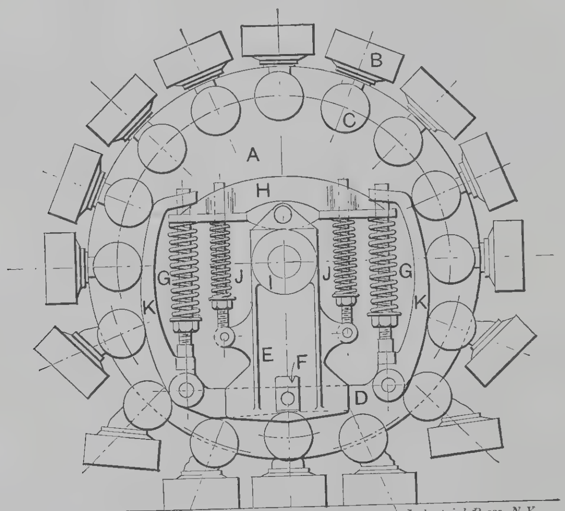
Transport (London). November 28, 1902. p. 512.

Longmans, Green & Co. have published a new book by B. J. Diplock, entitled "A New System of Heavy Goods Transport on Common Roads." The book is descriptive of a novel traction engine which is the invention of Mr. Diplock. The new traction engine has been dubbed "pedrail" by its inventor because of the peculiar stepping action of the drivers.

It is well known that the horse possesses a hauling power altogether out of proportion to its weight, and it is this the inventor has done his best to imitate, believing that the more nearly a mechanical tractive instrument on common roads assimilates in principle to the structure of the horse the better will be the result. A horse puts down a foot, to which is attached a lever or leg, and the foot is mounted on an ankle-joint which enables it to twist to any reasonable angle to suit the surface of the road. To imitate this, Mr. Diplock, after many years' experimenting, has succeeded in producing the "pedrail." Practically, the "pedrail" places feet on the ground, each foot supporting a roller on edge, and a short rail, supporting the load, is levered along by the spokes over the rollers. Its general appearance is strikingly shown in Figs. 1 and 2. In an ordinary railway a rail is laid down and wheels are run over it; in the "pedrail," wheels, or rollers, are laid down and the rail is run over them. The sliding spoke represents the horse's leg, or lever, and each leg is pivoted by an ankle pivot to its foot. Fig. 3 shows how the required conditions have been carried out. *A* is a disc keyed or fastened to the driving axle; mounted on the disc are sixteen sliding spokes, and on the outer end of each spoke is a foot, *B*, pivoted by a ball and socket joint so that it can turn to any reasonable angle to suit the surface of the road. On one side of each spoke, and projecting beyond the disc, is a small wheel or roller, *C*. The spokes are drawn inward by springs (one to each spoke) on the other side of the disc, radiating from the center. These springs are not shown in the drawing.



Figs. 1 and 2. The "Pedrail"—a Novel Traction Engine.

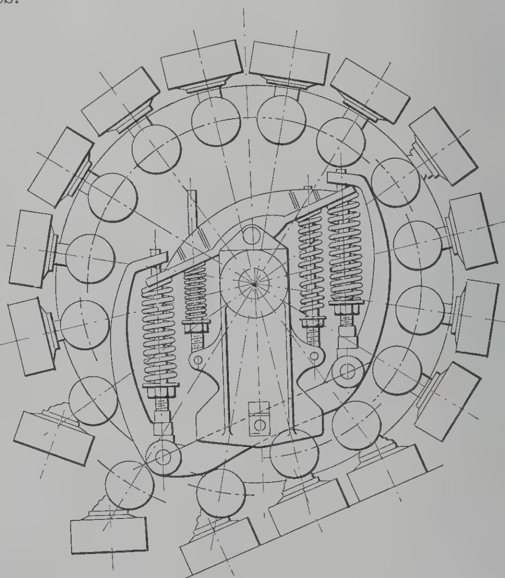


Industrial Press, N.Y.

Fig. 3.

Mounted on the axle-box *I* is a rail *D* pivoted to a flat plate or guide *E*, forming part of the axle-box. The pivot of the rail is free to rise or fall in a slot *F* in the plate *E*. The rail *D* supports the engine or vehicle by two springs *G* pressing against a top lever, pivoted to the top of the axle-box *I*. The two inner springs *J* serve to steady the top lever. Two guides *K* are provided to lead the rollers *C* under the rail *D*. The whole of the levers and springs mounted on the axle-box *I* come flat against the disc *A* so that the rollers *C*, which project from the disc *A*, are arranged round the guides *K* and rail *D*, as shown.

The disc *A* carrying the spokes, rollers, and feet, revolves, but the axle-box *I*, with its dependent lever, guides, rail, and springs, does not revolve, with the result that a roller starting from, say, the top of the disc, strikes on the guide *K*, and gradually forces the sliding spoke outward, thereby enabling the foot to turn on its ankle-joint by its own weight as it comes down, and to drop with its flat surface on the road, the roller then passing under the rail as shown. The bottom of the rail is slightly arched, as shown by the dotted line, so that the varying height of the rollers caused by the spokes being sloped or upright is equalized and the soles of the feet present a uniform level surface to the road. By turning the railway upside down, the parts coming in contact with the road are broken up into a number of comparatively small feet, which can twist in varying directions as required. Previous attempts at endless railways have failed owing to the attempt to place the rail next the ground. The rail, presenting a long, cumbersome surface to the road, did not lend or adapt itself to the varying inequalities of the road surface, thus causing breakages.



Industrial Press, N.Y.

Fig. 4.

Prof. Hele-Shaw reports that severe tests made of the "pedrail" were quite amazing in the results. The engine tested had two of the "pedrail" wheels in front and two common traction engine wheels behind. The action was described as practically noiseless, the most of the noise coming from the common wheels. The engine surmounted stones, planks and other obstacles with surprising ease and mud appeared to be no bar to its easy progressive motion, the contrast between the action of the "pedrail" wheels and the others being most marked. The engine shown in the photograph was equipped with only two "pedrail" wheels for experimental purposes, but the results have been so satisfactory that the other pair will be provided at once.

FRICTION OF BALL BEARINGS.

Abstract from Paper read by Mr. M. J. Golden before the American Association for the Advancement of Science.

Tests were made on hardened steel balls of 0.25, 0.3, and 0.5 inch diameter respectively at speeds varying from 200 to 2,000 rotations per minute. It was found that at speeds exceeding 2,000 rotations per minute, a shattering action was likely to occur in the bearing which quickly destroyed it. This action was especially noticeable at 5,000 rotations per minute, and above. The balls and races were destroyed by first becoming pitted, the pitting occurring in both. With heavy loads the balls failed by shearing into two parts. Any lubricant reduces the tendency to heat and shatter, but oil is better than grease.

Calculations from the figures taken during the test gave the coefficient of friction to be 0.00475, or less than one-half of one per cent.; though in a few of the tests the figure was found to slightly exceed one-half of one per cent. The friction was slightly greater with the smaller balls and at the higher speeds.

The formula deduced was gotten from so small a range in the sizes of the balls, and the degree of hardness in both balls and races was so nearly uniform in all those used, that it is not given to be used as a general formula, and only for what it may be worth after comparison with other formulas. The balls and races are to be of steel, thoroughly hardened and accurately ground.

Let the diameters be taken in inches, and the load in pounds: then

$D =$ diameter of the path of the balls on the races.
$d =$ diameter of the balls.
$L =$ load.
$F =$ friction.

$$F = L\left(0.005 + \frac{0.001}{d} + 0.005\,D\right)$$

WHEN IS AN ENGINE OVERLOADED?

Engineer. February 2, 1903. p. 143.

The editor remarks that engineers often complain that an engine is overloaded, and then pertinently asks:

"Upon what basis are overloads generally measured or figured? Is the extent of the overload determined with reference to a given point of cut-off, or a given number of horse power developed compared to the normal builder's rating, or to the effect of the load on regulation, or to the tendency to heat at the pins and bearings? Or is it based on a combination of these conditions; and if so, to what extent does each of the several conditions enter into the calculation, or to what extent are they taken into account when deciding questions of this kind?"

The power of a given engine depends upon the mean effective pressure and the piston speed; altering either, or both, changes the power developed. Some engines have carried so-called overloads with steam of a pressure so low that by doubling the pressure the engine would have been said to be underloaded. The question is, Where it is possible to thus increase the pressure, is the engine to be considered actually overloaded previous to the rise in pressure? If not, where is the dividing line between the pressures under which an engine is or is not to be considered overloaded? What is the proper piston speed to assume when figuring the horse power of an engine, and to determine the extent of overload, if any?

There has been in time past a feeble attempt to standardize a method of computing the horse power of an engine; that is, the nominal or rated horse power. Certain builders have adopted one method, other builders have adopted other methods, and engineers as a rule have methods of their own. To say that an engine is overloaded conveys but little information. The term "relatively overloaded" is no better. Relative to what? If there were a reasonable standard proposed, satisfactory to both builder and purchaser, there is little doubt but that it would be generally adopted, and we should hear less of overloaded engines, which are capable of carrying 25 per cent. more load by the mere turn of the hand. It happens oftentimes that the principal difficulties due to so-called overloads are traceable to a strenuous objection to running engines with more than the rated load. The lighter the load the easier it is to keep an engine in the habit of requiring little or no attention.

[The overload of an engine from a commercial and legal standpoint, is, of course, any excess over the builder's rating. An engine nominally rated at 100 horse power by the builder, is overloaded whenever it develops more than 100 horse power no matter if its proportions are so liberal that it can safely develop double the nominal rating. This, however, is only dodging the issue raised by the *Engineer*. An intelligent discussion of the question should lead to the adoption by the American Society of Mechanical Engineers and the Engine Builders' Association, of certain standard proportions and steam pressure as the basis of rating from which the normal safe load of steam engines can be calculated in a logical and scientific manner. The setting of such a standard should not be a difficult matter.—EDITOR.]

ELECTRIC SHOP DRIVES.

Discussion before the Engineers' Club of St. Louis, January 7, 1903.*

When electric shop drive was first advocated, the main advantage claimed was a large increase in efficiency over the old methods of belt and rope transmission. Of late, however, another, and, in my opinion, a greater advantage appears in the opportunity for increased shop output, resulting from the ability to operate the individual electrically-driven tool continuously at its maximum output. Shop managers are to-day keenly alive to the fact that, by means of electric drive, the output of individual tools may be easily doubled and sometimes trebled over that possible with the ordinary belt drive.

It is fair to say the discussion of electric shop drive is no longer one of merit, as compared with the old methods of transmission, but rather one of relative merit of the various electrical methods proposed. It is claimed on the score of efficiency alone that the best electric methods of to-day show an efficiency of 70 per cent., as compared with 20 and 25 per cent. by the old systems. Adding to this the possibility of double or treble output, the greater advantage of electric shop drive is such as to mean its rapid adoption in all branches of manufacturing.

Electric drive may be roughly classified under two headings —group and individual tool system. The former may be termed a compromise between the old and the best of the new.

In its best adaptations, group drive is so arranged as to have various classes of machine tools subdivided into groups of from 6 to 10 tools, each group being operated by a single motor. By such arrangement, the efficiency of shop drive is increased, roughly speaking, from 25 to 50 per cent. There is a further advantage over belt transmission from a single engine, in ability to operate any single group of tools entirely independent of the balance of the equipment. Independence of departments is fully secured by this means. A given group of tools may be completely shut down when not required, and a large loss of energy, otherwise unavoidable, cut off. This form of drive also permits of operation of any particular group of tools at night, with the main power plant shut down, provided auxiliary central station connection is possible.

The factory of the Wagner Electric Mfg. Co., of St. Louis, is one of a number of local examples of group electric drive. By means of reserve connection with outside central station service it is possible to run any special group of tools overtime, or all night, without operating the company's isolated generating plant.

Engineers agree, however, that the individual motor system is the ideal one where variable speed service of tools is necessary or desirable. In the group system variable speed is impossible, and the individual tools must be regulated for speed variation through inherent or cone adjustment.

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* The reader is also referred to the system of the Crocker-Wheeler Co., described in the September, 1902, number,—EDITOR.

Both group and individual drive systems may be arranged for either direct or alternating current motors. For all constant speed service the alternating current motor stands on an equal footing with the direct-current motor. In fact, by reason of its greater flexibility and inexpensive maintenance, the alternating-current motor for such work has a material advantage. The disadvantage of the alternating-current motor appears for all service requiring frequent starting and stopping, and wide speed variation. No entirely satisfactory system has yet been evolved by which speed variation comparable to that possible with the direct-current motor can be secured.

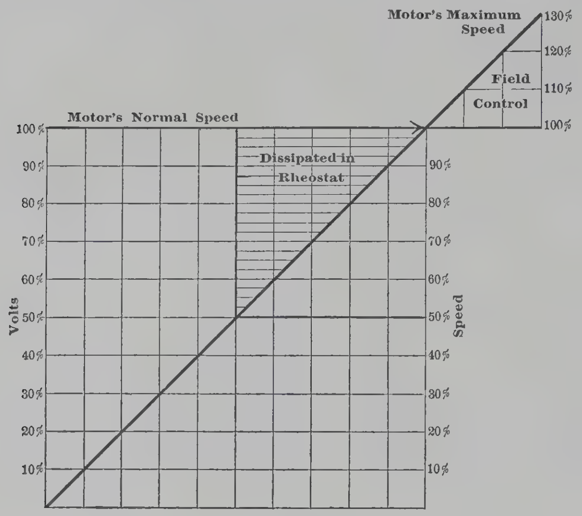


Fig. 1. Rheostatic Control.

The ideal alternating drive would be one having constant speed alternating-current motor, equipped with auxiliary mechanical device, where necessary, by which a wide range of speed variation could be secured smoothly and simply. Mechanical engineers are working on this problem, and such a system may come. I have seen one striking example of it in the shops of the Lodge & Shipley Machine Tool Co., at Cincinnati, where their "speed variator" is used.

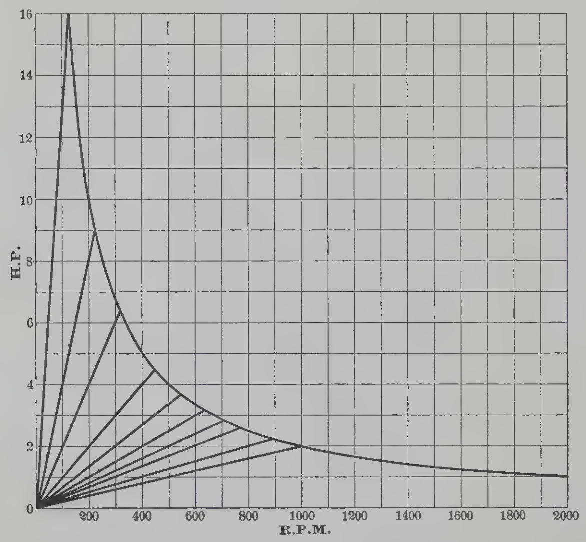


Fig. 2. Variation of Shunt Motor Capacity with Change of Speed Secured by Variation of Shunt Resistance.

With alternating-current motor drive, shop lighting from the same mains feeding the motors is possible and convenient, while with the prevailing methods for variable direct-current motor drive the shop lighting system is practically entirely independent of the motor service system.

The individual drive system may be generally classified under three headings: Rheostatic control systems; multi-voltage control, and special systems for special tools.

In the rheostatic control system the motor is of the well-known shunt type, supplied from a constant potential system of distribution. Speed variation above the normal speed of the motor is secured by the introduction of resistance into the motor shunt field circuit; speed variation below normal is secured by the introduction of resistance into the armature circuit. This is illustrated in diagrammatic form in Fig. 1.

The disadvantages of the system are its inefficiency when armature resistance is made use of for speed reduction, and variation of speed on a given armature resistance with variation of load. To overcome both disadvantages, motors have been designed capable of very wide variation in speed by variation of field resistance. A well-known motor designer stated in a recent discussion before the American Institute of Electrical Engineers that he had designed and built a motor capable of speed variation of one to three (simultaneous load variation not stated) on variation of field resistance alone. In the same discussion an equally well-known motor designer claimed that the normal motor was not capable of over 30 per cent. increase in speed, under full load, by field resistance variation.

I think general practice is to confine speed variation, by weakening the shunt field to 30 per cent., and any motor capable of greater variation can hardly be termed a standard motor. The limit of such variation is determined by commutator sparking. A motor of given capacity may be operated, of course, at much reduced capacity for speed variation of 10 to 1. The reduction of capacity, with increase of speed, in this case, is illustrated by the curve, Fig. 2. This curve fairly represents the variation in one of the best known makes of direct-current motors. For example, a 10 H. P. motor, operating normally at a speed of 200, will have an output of 1 H. P. only, at a speed of 2,000; speed variation being secured entirely by weakening of the shunt field.

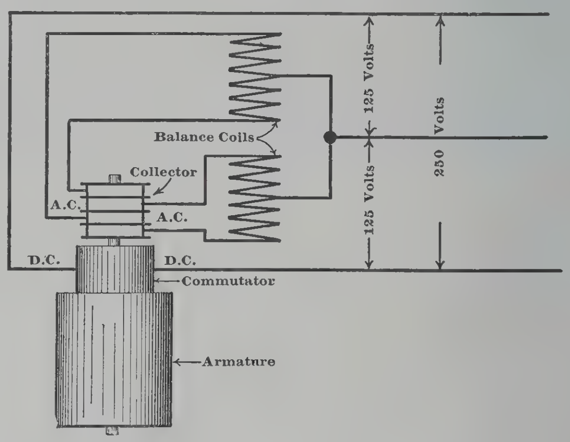


Fig. 3. Westinghouse Three-wire System for Variable Speed Control.

Multiple Voltage System.

There are several of these systems. The Westinghouse and the General Electric Companies advocate a three-wire system, as illustrated in Fig. 3. Their usual direct-current generator is provided with a set of collector rings, these collector rings being connected to the armature winding in such a way as to establish an exact two-phase relation between the potentials of the two pairs of collector rings. By means of choking coils connected as shown, the neutral wire of the three-wire system is exactly and constantly maintained, irrespective of load, at zero potential relative to the outside wires.

In connection with this three-wire system, the individual tool is equipped with a standard 250-volt shunt motor, and speed variation is secured in two ways: First, by running the armature either on 250 volts (normal speed condition); or by running it on 125 volts (half normal speed condition). For any speed desired between normal and half normal, shunt field resistance is introduced. If I understand the system correctly, the shunt motor is capable of 100 per cent. speed variation by variation of shunt resistance when the armature is on half voltage—and correspondingly at half load. If speed above normal full speed is required, shunt resistance is again introduced.

The Bullock Electric Mfg. Co. advocate a system as illustrated in Fig. 4. A generator, standard in every respect, is supplemented by a small motor-generator set, the design of which is such that a four-wire system of distribution is established, providing for six different voltages upon which the motor armature may be operated without the use of armature resistance. The form of motor used is the standard shunt wound type. Without the use of field resistance, six speeds may be secured, corresponding in ratio to the ratio of the voltages supplied by the four-wire distribution system. By means of shunt resistance any speed intermediate to that possible with the several armature voltages may be secured. The motor generator set is so proportioned as to take care of the unbalanced load. This system is also adaptable to three-wire distribution, where less speed variation is required, and in the event of three-wire distribution an increased amount of field regulation is introduced. This three-wire distribution differs from the Westinghouse and General Electric system in that the voltages on the two sides of the intermediate wire differ, thus giving three distinct pressures instead of two. The Bullock system represents the multiple voltage idea carried to its fullest development, and is the extreme of present commercial systems, from the ordinary rheostatic control system. The difference between these systems, from the standpoint of efficiency, is illustrated in Fig. 5, as plotted from the test results on a 25 H. P. motor.

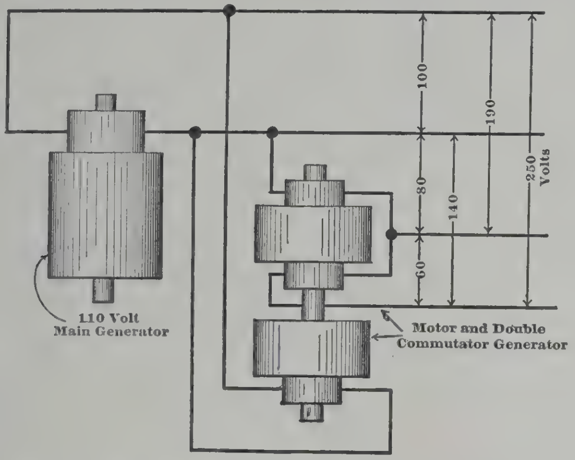


Fig. 4. Bullock Electric Mfg. Co.'s Multiple Voltage System.

Another form of variable speed equipment is advocated by the C. & C. Co., of New York City. In this case the motor is special, being provided with two entirely independent armature windings. On normal speed operation the two armature windings are connected in parallel, the field winding being in shunt. For half speed the two windings are connected in series; intermediate and excess speeds are secured by a combination of armature and field resistances.

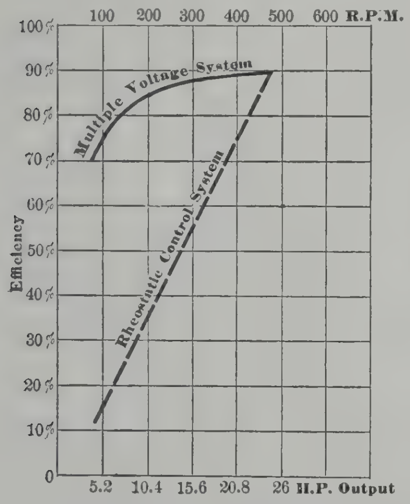


Fig. 5. Efficiency Curves, Multiple Voltage and Rheostatic Control Systems.

* * *

There is a general opinion that concrete is damaged by freezing; but it has been ascertained that concrete floor arches that have been frozen solid, thawed out, and frozen again, were in no way changed, but when finally thawed and dried out were as strong in every way, as far as could be determined, as those which were not frozen.

NEW NO. 3 MILLING MACHINE.

The half-tone, Fig. 1, illustrates a new milling machine that has just been brought out by the R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. The principal novelty of the machine is the use of double friction back gears. The advantages derived from this type of back gearing are: The cone can be of better proportion than when single back gears are used; a greater number of spindle speeds can be obtained; higher belt speeds and better belt contact are obtainable, and the drive is twice as powerful as on the regular machine.

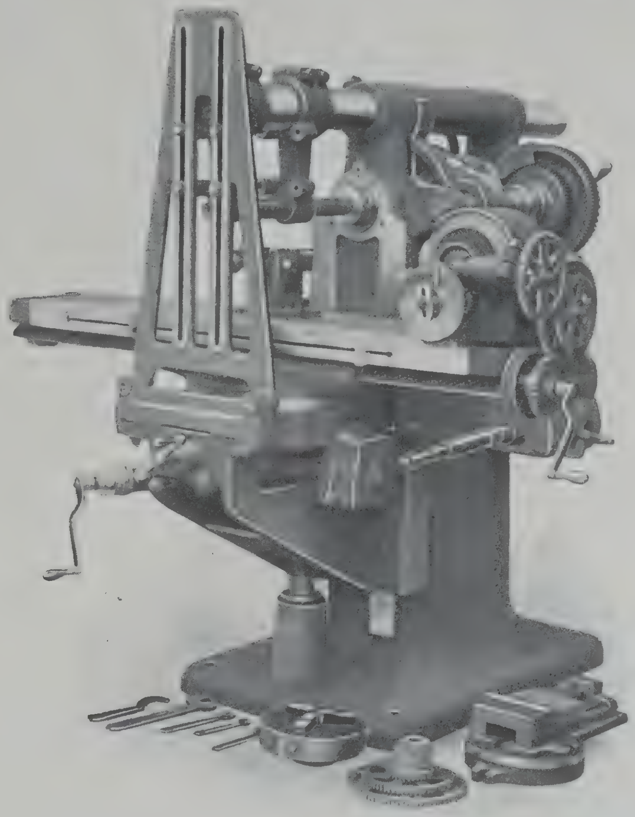


Fig. 1. Le Blond No. 3 Universal Milling Machine.

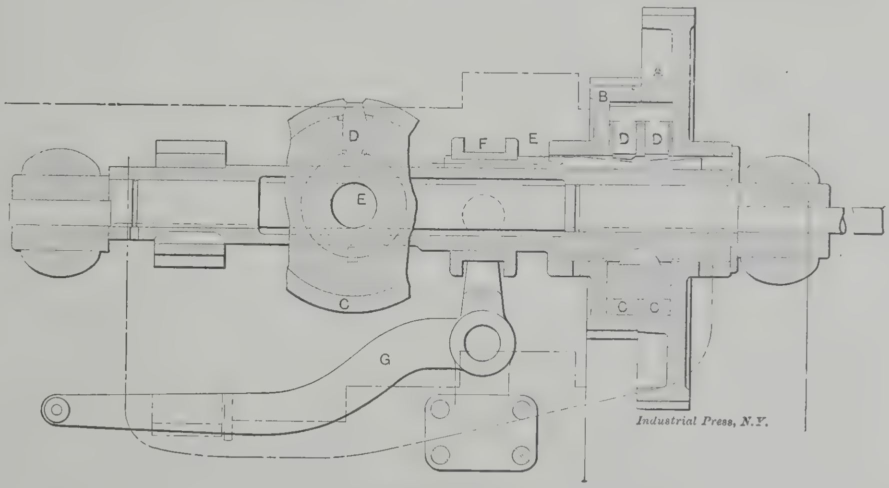
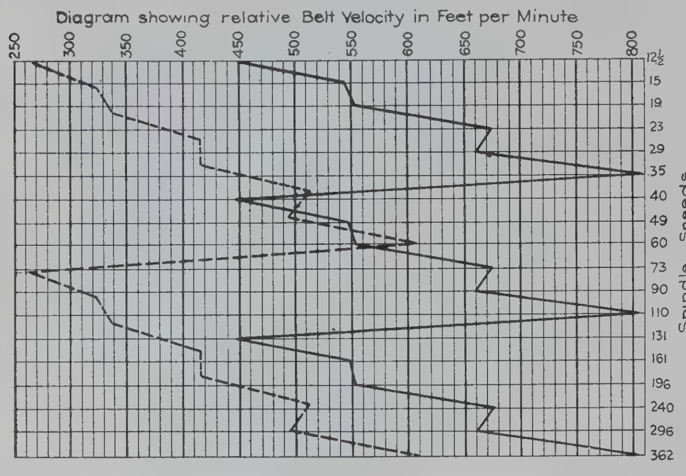


Fig. 2. Arrangement of Friction Back Gears.

The construction of this back gear is shown very clearly by the drawing, Fig. 2. It consists of a ring, *C*, that is opened by the plug, *D*, the sides of which are tapering. This plug is forced up with a taper key *E*. The friction ring is made to snap tight on a spool, so that when released there is absolutely no friction on the gear, as the band comes tightly to its place on the spool. The wedge or key is carried by a yoke *F*, which in turn is operated by the lever *G*, shown at the side of the column. The special advantage of making the friction this way is that its power is multiplied a good many times before it reaches the spindle; since this friction merely drives the pinion on the back gear quill, which in turn drives the face gear.

Comparing the relative spindle power of a double back geared machine with that obtained by the ordinary four-step cone and single back geared machine, the large step of the spindle and countershaft cones being the same in both instances and both machines calculated to give a range of spindle speeds of from 12½ to 362 revolutions per minute, we find that the countershaft on the double back geared machine runs at 180 and 220 revolutions per minute, while on the single geared machine it runs at 135 and 166 revolutions per minute, thus giving the double geared machine a gain in countershaft speed, or power, of 33 and 30 per cent., respectively.

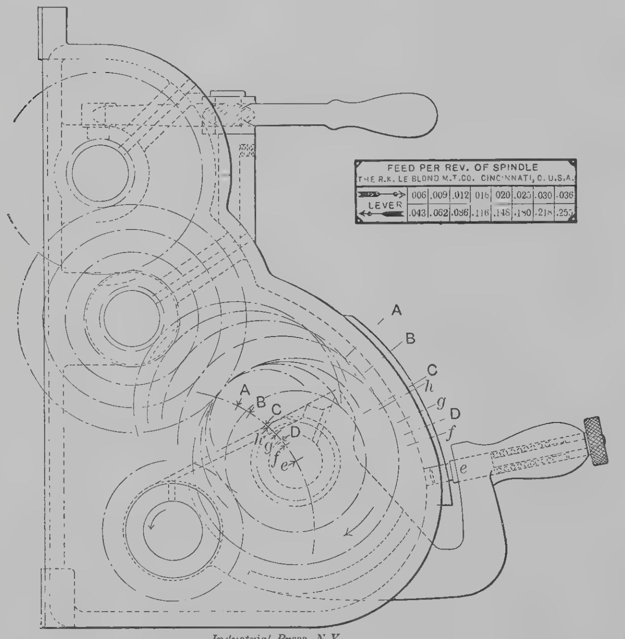


The Broken Line indicates Belt Speeds on the Single Geared Machine.
The Full Line indicates Belt Speeds on the Double Back Geared Machine

Fig. 3.

The cone diameters on the double back geared machine are 13, 10¾ and 8½ inches. On the single back geared machine they are 13, 10 13-16, 8⅝ and 6 7-16 inches in diameter. This gives an increased diameter on the smallest cone step of the double back geared machine of 2½ inches, amounting to 32 per cent. increased belt contact. This pertains as well to the small step of the countershaft cone.

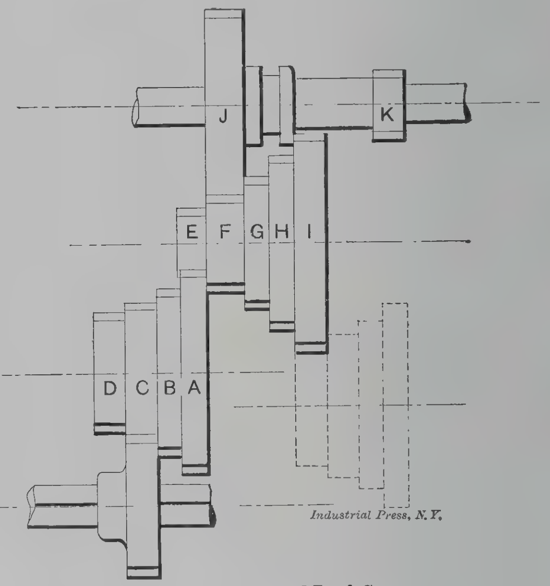
The relative belt speeds obtained are shown graphically in the diagram, Fig. 3. The broken line indicates those on the single geared, and the solid line on the double geared machine. It will be seen that when both machines are running at the slowest speed of 12½ R. P. M., the double back geared machine has a cone belt velocity of 447 feet per minute, while the single back geared machine has a velocity of 267 feet per minute, showing a gain for the double back geared machine of 70 per cent. in power. This proportion is maintained until we reach 35 R. P. M. when, engaging the low ratio of back gear, the double back geared machine reduces the belt speed to about that of the single geared machine, from which point the belt speed then increases in favor of the double back geared machine until at 75 R. P. M. there is a difference in the belt speed of 390 feet, or a gain of 150 per cent. When the machines are running on the open belt the double back geared machine has an increased belt speed varying from 70 to 200 feet, as will be seen from the diagram.



Industrial Press, N.Y.

Fig. 4. End View of Feed Box.

The ratio of the back gears is also much more favorable on the double back geared machine. Calculating the back gear ratio so as to give an even grade of speeds running in geometrical progression from 12½ to 362 R. P. M., we get a back gear ratio of 3.3 and 10.34 on the double back geared machine, and 6.2 on the single back geared machine, amounting to an average increase of 74 per cent. in back gear power. Another advantage of the double back geared machine is that but one-third of the speed changes are obtained with the open belt while on the single geared machine one-half of the changes are obtained in this way. With the countershaft and double friction back gears, four changes of speed are obtained without shifting a belt, a lever at the side of the column enabling the changes to be made without stopping the machine. When the cone drive is used the back gears can be thrown out of mesh the same as on any ordinary back geared machine. The cone and spindle drive are proportioned to give the correct cutting speed for eighteen different diameters of cutters, ranging in size from ½ to 15 inches, with a speed of from 12½ to 362 revolutions per minute. These cutter sizes are figured for a cutting speed of 50 feet per minute, which, under ordinary conditions, is the rate at which cast iron can be milled on these machines.



Industrial Press, N.Y.

Fig. 5. Arrangement of Feed Gears.

Another important new feature of these machines is the feed change box, an end view of which is shown in Fig. 4. The feeds are arranged in geometrical progression ranging from .006 inch to .255 inch per revolution of the spindle. The box is composed strictly of spur gears, and the transmission from the spindle to the box is through spur gears. Any feed can be instantly obtained by the movement of a single lever, while an engraved plate attached to feed box indicates the feed obtained. The lower lever gives a fine and the upper lever a coarse graduation of feed. Each handle is entirely independent of the other and can be worked separately or in unison. With the upper lever in the first position we get all feeds from .006 inch to .036 inch, or the range generally used for direct cone drive. With the upper lever in the second position we get all feeds from .043 inch to .255 inch, or the feeds used when the spindle is back geared.

The arrangement of the feed box gears will be clearly seen by reference to the diagram, Fig. 5. On the high spindle speeds and high feeds the drive is through pinion *K*. On slow speeds when heavy cuts are taken the feed is through gear *J*, increasing the feed and power of the feed box seven times. By meshing each of the gears on the lower cone with the gear *I* on the upper cone, and each of the gears on the upper cone with the gear *A* on the lower cone, eight changes of speed are obtained. By moving the gear *K* into mesh with the gear *I*, eight more changes are obtained.

NOTES OF TRAVEL.

A UNIQUE ITALIAN PUMP AND HOW ITS PHOTOGRAPH WAS OBTAINED.

Editor MACHINERY:

In the neighborhood of Naples and Pompeii as well as the region lying between them, each of the small farms or vegetable gardens is provided with a pump for irrigation. The form is unique and nearly the same in every case. The one illustrated is typical of them all. There is a broad, shallow well with a low wall in the front and extending back a short distance on the sides. The back part is arched over, and between the front and back the walls are carried up high.

One end of a horizontal wooden shaft rests on the highest part of the wall in a suitable bearing for allowing it to rotate. The other end of the shaft is supported by a cross-beam between a stone pillar at one end, and a wooden post or another stone pillar at the other. A bucket-chain hangs over a chain-wheel on the shaft and down into the water. In the illustration the buckets are of iron. They are suspended by two endless ropes.

The place where the greatest variation from this particular form of pump occurs is in the buckets and their suspension member. In a few cases a broad band is used instead of the two ropes. This band is made of cloth or woven grass. The buckets used on this band are sometimes in the form of an Italian slipper with the high-heel removed—the kind of slipper that covers only the front of the foot and has a sole extending back to the heel. Other forms resemble more closely the baskets used by the American Indian squaw for carrying her papoose. These buckets are made up of wood, leather and grass or straw. Each bucket is attached to the band so that the toe, in the slipper form, is down on the water-carrying side, and on the down side of the band it is, of course, inverted. When the chain-wheel is turned, the water carried up by the buckets is emptied out as they pass over the top of the wheel. It runs into a stone channel or canal on the top of the arch. The long back extension of the slipper-shaped bucket is for carrying the water well over into the canal. The latter extends out through the gardens as a stone structure with outlets along its sides that may be opened or shut at will.

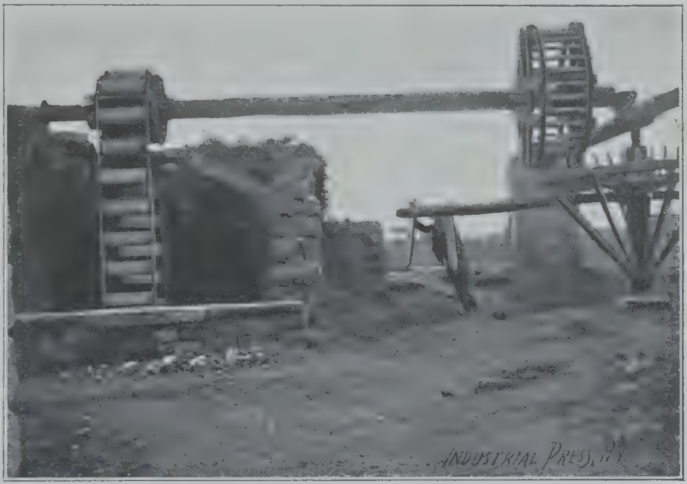
The device for driving the horizontal shaft is primitive in the extreme. A wooden pin gear on it engages with a crown gear on a vertical shaft. The teeth of the crown gear are mere wooden pins roughly rounded and sharpened almost to a point. The shaft of the crown gear rests on a large stone at the bottom, and the upper end is supported by the same beam that carries one end of the horizontal chain-wheel shaft.

In only one pump out of some fifty or more that were seen was any other form of gears used. In this single exception there were cast-iron bevel gears of modern form.

The motive power for pumping is furnished either by a man or woman, or by a small horse or donkey. Small holes for traces are provided in the two down projecting pieces near the end of the long driving arm.

The securing of the photograph occupied a morning full of interesting occurrences. A great number of the pumps had been noticed the day before during a round trip between Naples and Pompeii on the steam railway. The speed of the train, which covered the twelve miles in an hour and a quarter, was not too high to permit rather close inspection of objects along the way, including pumps and wells. The latter two were so interesting that a decision was made to secure a photograph the next day, if possible. Accordingly, a horse street car was boarded in the morning on a line leading from Naples toward Pompeii. A lookout was kept between the houses for near gardens. The speed of this car, with its diminutive horses, allowed this very satisfactorily. Finally, at Portici, gardens were seen, so the car was halted. Upon our starting to alight, one of the horribly deformed, but wonderfully agile beggars so common in Italy, noticed that his legitimate prey, foreigners, was at hand. This particular pest had one leg bound up before him across his chest. Otherwise he appeared strong and healthy. He traveled on one foot and two hands. The street was wide and the pavement was covered half an inch deep with filth of the consistency of mortar. But he came from the curb to the car with great speed and placed himself immediately before the step, so that it was impossible to get off without stepping against him. This was highly undesirable on account of the condition of his clothes. Having learned the importunateness and persistency of his class, a quick turn was made to the opposite side of the platform. But he made the change of position to the other step with the quickness of an active dog, and was there in time to receive his victims. A vigorous intimation that the point of an umbrella would be used if he did not move aside, persuaded him to grant free passage.

A large macaroni factory occupied one side of the street leading back to the fields. In front of it the sidewalk, on the main street, was filled with the newly-made food hung out to dry. Cane poles resting on wooden horses formed the necessary supports. These poles were some three feet from the ground, and close together. The moist macaroni hung down nearly to the ground. Swarms of flies were sampling the goods and disporting themselves over it. No dogs were tasting it at the instant, but some were in the immediate neighborhood. The suspended strings act well as a flybrush for a dog passing through them, and the moist tubes must tempt his taste. The whole was not conducive to a relish of Italian macaroni.



A Unique Italian Pump.

The side street was paved as far back as the rear of the macaroni factory; and it also had curbing and sidewalks. One of the walks was deep mud. The other was not bad, comparatively, in this feature, and was fairly safe in daylight when a sharp lookout before was kept. But it would be wiser to wade in the mud at night, than to take the risk of falling into one of the numerous and large, deep holes with which it was well supplied. There was a large sewer under the walk, with numerous manholes. These were square and nearly two feet both ways in the opening. The frame and cover were both of stone. The cover was thick and heavy. They were all there, but had been dropped through the opening into the sewer, possibly for safekeeping. In that position they prevented too swift a current with its probable danger to the walls. The adoption of a square manhole for such a purpose and construction is an indication of the good engineering that prevails in the country, except the extreme northern part.

The street improvements stopped short at the rear end of the factory. Here the street dropped abruptly down a few feet and became mere ridges of mud.

A path leads from here to the pump, and a peasant girl was at work near this path, who graciously agreed to having the pump photographed as soon as our wants were made known. By the time the most suitable point of view was determined, five other persons had arrived on the spot—the man at the pump, a younger man, and three Italian maids. They were all much interested and pleased by the tiny image of the pump in the finder of the camera. Two looks apiece were necessary to gratify them. Then they insisted that we must see the pump operating. It had been wet weather for some time, so the pump had been idle. An end of a clothesline had been tied to one of the pins in the crown. This line was very long and filled with fresh washed white clothes except a short portion between the pin and a tree close to the line. The line had to be loosened in order to turn the pump. So all Italian hands set to work to transfer the fastening from the pin to the trees. This was done in what seemed a very neat and satisfactory manner, and the work was proceeding smoothly, when suddenly there arose a loud and angry clatter at the opposite end of the line where it was attached to a house. A glance in that direction showed about half the clothes lying flat on the newly upturned earth. A prop had fallen during the process of transition of the anchorage. An old woman was approaching, shaking her fist at the party, and pronouncing anything but blessings upon their heads. The photograph of the pump was taken immediately after.

There was but little time left for returning to Naples and catching a train to Rome. So the amateur photographers made haste to depart. Arriving again at the main street, no car could be seen. A one-horse carriage (vetture) was at hand, however. It might more truly be called a half-horse carriage, the horse is so small. The driver cheerfully agreed to take the two of us home, a distance of more than six miles, for one lira (twenty cents). It took him an hour and a quarter to do it, traveling faster than the ordinary Neapolitan vehicle of the same class. He was satisfied with the lira when it was given him at the end of the journey, and saluted politely without even a hint of a fee for a drink. But his fares were American, and could not see him go with this absurdly small sum for the service, as most of his own countrymen would undoubtedly have done. He had guided his nag carefully around the numerous holes and pitfalls in the way, by judicious use of the reins and tiny crossbar over the nose of his tiny beast.

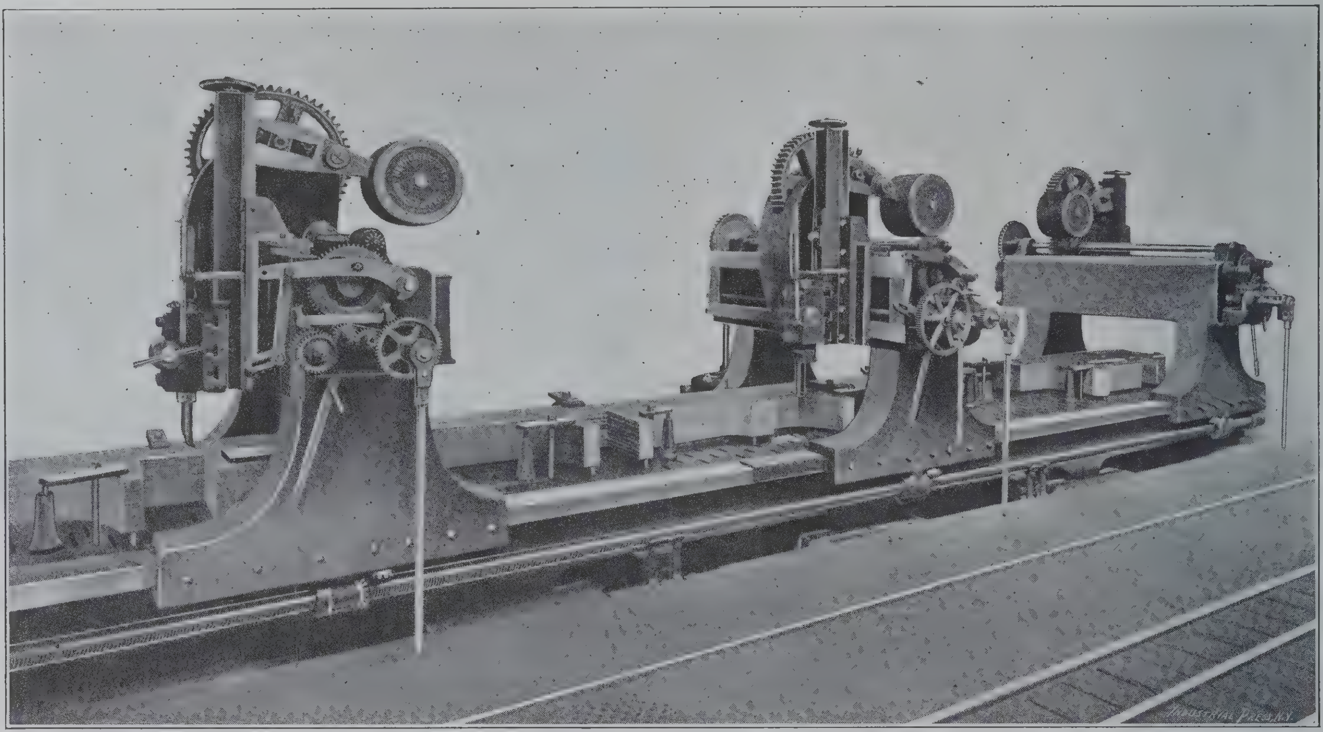
None of the horses for this public service has a bit in its mouth in Naples. Nothing is placed in the mouth. A metal bridge, usually brass, passes over the bridge of the nose, a considerable distance up from the end. It is something of the nature of the bridge of a pair of spectacles. The head harness is something like a halter, with this bridge in place of the nose strap. A six to eight-inch bar extension is on each end of the bridge. These stick out on each side of the horse's head, and the reins are attached to their extremities. The animals are so small that they can be readily controlled with this harness. FORREST R. JONES.

Manchester, England,

AN ENGLISH LOCOMOTIVE FRAME-PLATE SLOTTING MACHINE.

The illustration presented herewith shows a very interesting machine of English construction that is used for slotting and drilling locomotive frame-plates. It is usually fitted with an electric motor-driven countershaft and takes about 25-horse power in ordinary working conditions. The bed and table are of box pattern, planed on the top and sides and provided with suitable bolt slots. The cross slide and uprights or heads are also of box pattern cast in one piece. They are planed and fitted to the bed and arranged, with hand and variable self-acting feed along the bed by means of cam levers, cut change wheels, miter wheels, revolving gun metal nuts and two square thread steel screws of large diameter. One of these is on each side of the bed supported at intervals by tumbler bearings. The longitudinal and transverse feed can be worked separately, or the two coupled, by swing frame and change wheels, giving a self-acting diagonal transverse for slotting outside the axle box horns and cylinder seatings.

The planed carriage is fitted to cross slide with hand and variable self-acting feed across the bed. The front face is fitted with a balanced vertical ram or tool slide adjustable vertically by means of a hand wheel, square thread screw and gun metal nut with locking bolt. The front face is provided with T slots, tool-holders and a removable self-acting tool box for slotting radii. The length of stroke is 14 inches, and there are three heads on the machine tool shown. The length of the bed over all is 36 feet and the total width 6 feet 1 in., while the width between the uprights is 5 feet 1 in. and 34 feet is the length of the plates that can be slotted. The width of the plates which can be slotted is 5 feet and the height from the face of table to the underside of cross slide is 2 feet 6 inches.



Machine for Slotting and Drilling Locomotive Frame-plates.

The driving is by means of a three-cone pulley of large diameter for wide belt of high velocity. There are two pairs of bevel gears, spur gear and link motion giving quick return stroke. Each head can be started and stopped independently by means of friction clutch coupling operated by a lever attached to the upright.

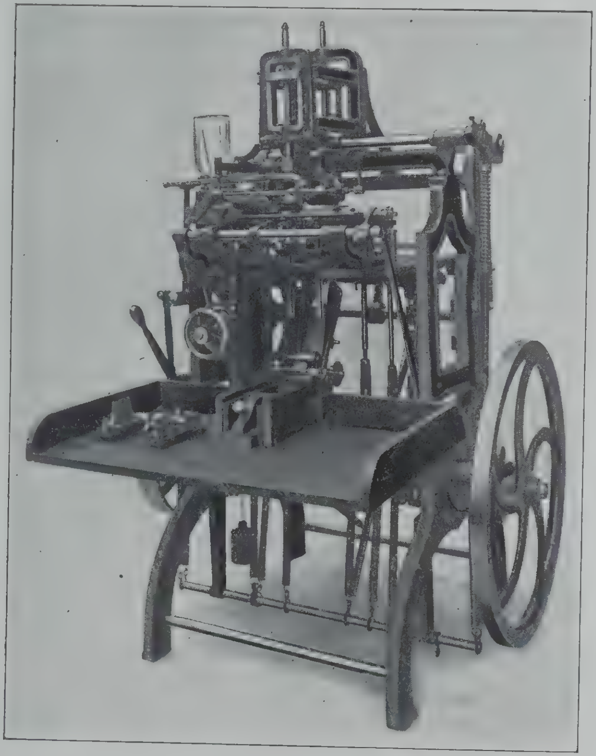
The diameter of the steel spindles for drilling is $2\frac{1}{2}$ inches and the machine is designed to bore in diameter up to 10 inches and in depth up to 15 inches. The drilling, tapping and studding attachment is fitted to the back of each cross slide, consisting of cross slide planed to receive spindle slide or carriage, adjustable transversely by hand wheel, pinion and rack. The hard steel, balanced spindle slides in cast iron sleeve which revolves in conical bearings, having lock nuts and friction washers for taking up the wear. It is driven from the slotting machine cone pulley by single and treble gear, which are placed in the spindle slide, thus giving off the power direct to the spindle. There is a clutch reverse motion for tapping and studding, with quick hand reverse for running the spindle to and from its work.

The feed motion of this tool is self-acting and variable by a three-speed cone pulley, double worm wheel and cut steel pinion and rack. There is also an instantaneous disengaging motion and hand feed. The screw keys necessary for working parts of the machine are made of mild steel case-hardened. The top driving apparatus comprises hangers, cone pulley, tight and loose pulleys, strap bar and forks. The screws and shafts are of steel and the working nuts of gun metal, while the working pins, joints, nuts and washers are case-hardened. This machine was built at the Ancoats Works of John Hetherington & Sons, Ltd., of Manchester.

* * *

AN ENVELOPE FOLDING MACHINE.

The machine illustrated below is one of a class of machines that help to turn out the enormous quantities of envelopes that are used all over this country annually. This photograph, which was obtained through the kindness of Mr. F. B. Powers, Springfield, Mass., was built for making the seed pouches that are used by the seed dealers, and is simpler and less elaborate than the machines used for producing the commercial envelope. The machine is practically automatic, but requires the services of an attendant whose duty it is to watch every motion of the machine and to supply it with paper blanks and gum whenever needed. The tender also boxes the bags after they have been counted by the machine.



Machine for Folding Envelopes.

The paper blanks are cut out by a knife, of the proper shape, under a powerful press which produces about 500 sheets at one cutting. These blanks are placed upon an elevator table by which they are fed to the machine as they are needed. Suitably gummed pickers take the top sheet from the feed table and drop it onto the carriers which convey it to the creasing box and thence down to the folders which fold the blank on a trap door arrangement. From here the folded blank is dropped onto a conveying chain, composed of specially-shaped links which hold the envelope in proper position for the gummed flap to dry. From this chain, at a given point, the packets are dropped into the delivery box and counted in packages of the number desired, usually 25 in each package.

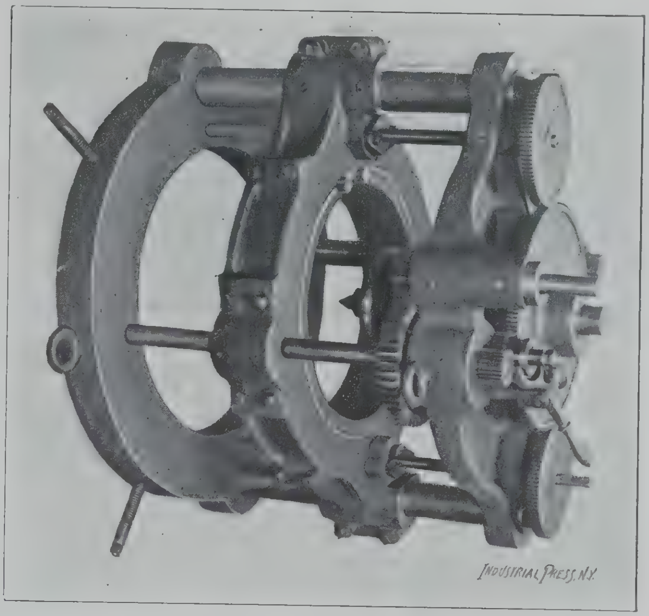
The rate of production of these machines is about 110 bags or envelopes per minute, which would amount to 66,000 per day of ten hours. In all such machines there is, however, a percentage of loss in production but 60,000 per day is usually expected when the machine is in good order.

F. W. Clough.

* * *

A CRANKPIN TURNING MACHINE.

One of the most difficult jobs in connection with steam engine repair work is that of re-turning large crankpins, since it is unpractical to remove them from the disks and the turning must be done in place. The cut illustrates a machine that is designed for this sort of work and is capable of turning a crank pin up to 15 inches in diameter and 12 inches long. The machine is placed over the pin with the center, shown at the right hand side, fitting the female center in the end of the crankpin. The four radial screws at the outer end of the machine are then used to adjust it properly in line with the pin, after which it is clamped to the crank by bolts and the adjusting screws are backed off out of the way of the cutter. In some pins the outer end has a tapped hole, used for bolting on a cap, and when used with such pins the center shown in the cut is replaced by a rod and bushing which fit the tapped hole. The end of the rod projects from the center of the outer end of the machine and is clamped there by a split hub.



Machine for Turning Crankpins.

The cutter-head, carrying the turning tools, is held in an annular ring which revolves in a traveling head frame. On the back of the ring is cut a gear so that it may be driven by a pinion connected to the driving shaft. Upon this shaft may be mounted a pulley or grooved sheave so that the machine can be driven from any convenient belt or rope drive. Upon opposite sides of the frame that carries the cutter-head are two feed screws which are connected at the top by suitable gears meshing with the feed gears, on the driving shaft, and thus providing for automatic feed. When finishing fillets, at the top or bottom of a pin, the automatic feed may be disconnected and the head fed by means of a crank applied to the end of one of the feed screws. The machine is the product of H. B. Underwood and Co., Philadelphia, Pa.

* * *

It is estimated that 110,000,000 railroad ties were used in this country the past year. One firm has contracts for ties extending over a period of eight years and will cut timber every year off 300 square miles of land. From these figures some idea can be had of the quantity of timber used in this country for railroad ties, and also of the importance of some method both for preserving the ties against decay and preventing the rails from cutting into and destroying them.

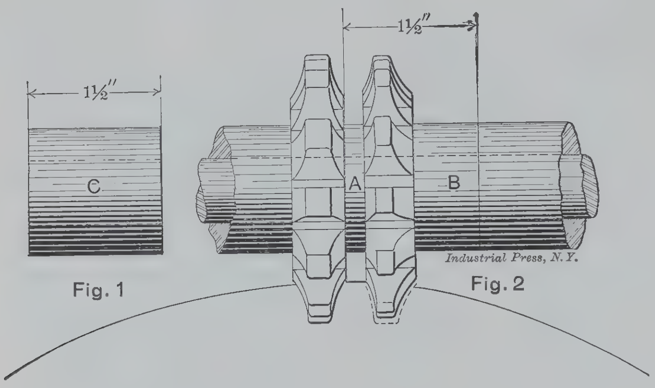
LETTERS UPON PRACTICAL SUBJECTS.

ROUGHING AND FINISHING GEARS SIMULTANEOUSLY.

Editor MACHINERY:

Having a large number of steel gears to cut on an ordinary horizontal milling machine and an accurate job being required, I decided to take both a roughing and finishing cut; as it is well known that a single cut in steel does not leave the teeth in very smooth condition. As time was an important element in the job it was arranged to take these two cuts simultaneously, thus saving the time that would be necessary to index the gears around twice.

To do this the roughing cutter was first put onto the arbor with the collar *C*, Fig. 1, on the inside. This collar was just 1½ inches wide. Then one space was cut with this cutter alone, set to cut .015 inch less than full depth of the tooth.



Roughing and Finishing Gear Teeth.

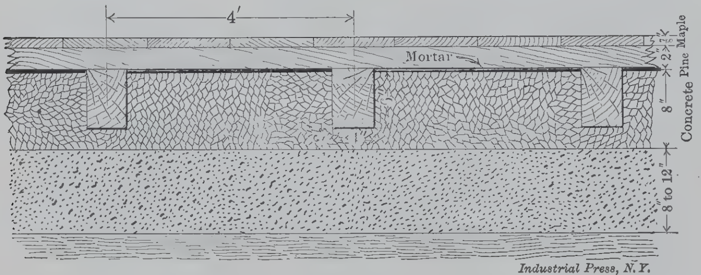
This cutter was then taken off and the 1½ inch collar removed. In its place the roughing cutter was put on with two collars *A* and *B*, whose combined thickness together with that of the cutter equalled 1½ inches. The collar *A* was of such thickness that the roughing cutter would come in the center of the tooth space, as shown by the dotted lines in Fig. 2. The finishing cutter was then put in place, the table raised .015, and the finishing cut taken through the space that had previously been roughed out. While this was being done by the finishing cutter, the roughing cutter was stocking out the next space at the right. Once started as above described, the gears were cut exactly the same as when using a single cutter and the result, in obtaining smoothly-finished gears, was most satisfactory. R. A. LACHMANN.

Chicago, Ill.

NOTES ON SHOP FLOORING.

Editor MACHINERY:

Having read with much interest Mr. Perrigo's article in the February number of MACHINERY, upon the subject of shop floors, I would call attention to a style of floor that he does not mention, but one which has proved very satisfactory in many places where it is known to have been in use for a long time. It consists of a foundation of sand or cinders to a depth of from 8 to 12 inches, depending upon the condition of the earth, which is finished off at a depth of 11 inches below the floor grade. Upon this are placed 4 x 6-inch sills or nailing strips, blocked up until level, with the under edge raised 2 inches from the sand or cinders. Between and under these sills is tamped a concrete composed of eight parts crushed stone or screened gravel, four parts sand, and one part natural (Louisville) cement. This fills as near to the top of the sills as possible but should not project above them. Upon this, after about 12 hours' drying, is spread a rather thin layer of mortar, or grout, composed of one part natural cement to two parts sand. This is struck off flush with the top of the sills, upon which the sub-floor is laid. This floor is made of 2 x 6-inch dressed and matched pine, well spiked into place before the grout has become dried. In the presence of dampness, where rotting is feared, a bed of hot tar may be placed upon the concrete before laying the sub-floor.



Section of Shop Floor.

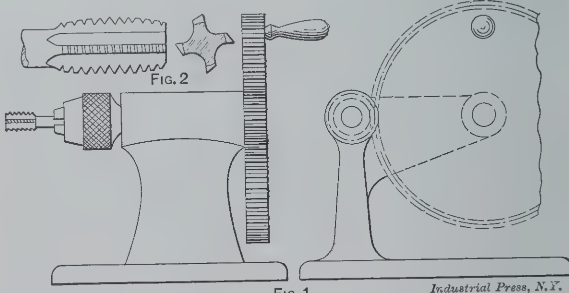
After the machinery has been placed a flooring of ⅞-inch maple, dressed and matched, 3 inches wide, is nailed diagonally on top of the sub-floor. This maple can be obtained for about $18 or $20 per thousand by taking the short lengths and pieces that are off color, but which are just as good as any for this purpose. The resulting floor is very satisfactory, being easy to truck upon and neither splintering like pine nor crushing like concrete and there is no danger from fire, as in the floor laid on joists with ventilation below. When the maple wears out it can be easily renewed, the floor is easy to keep clean, and what is of prime importance—it is cheap to construct, as the cost is about 10 cents per square foot after grading.

For a "scaffold," or cupola floor, I have found rolled steel plates with the raised diamond pattern to be very much better than the cast iron plates. These can be obtained in widths up to 40 inches and in lengths to 16 feet. Although their first cost is a little more than the cast iron plates, they are more reliable and wear much better. They should be laid and riveted to steel beams. C. J. M.

A SAFETY TAPPING ARRANGEMENT.

Editor MACHINERY:

Having tried a great many devices for tapping small holes and found that they all require more or less skill in their operation, and even with a skillful operator taps were frequently broken, I have made the little tapping machine that is shown in Fig. 1, and find it very effective. With it, it is practically impossible to break the taps no matter how small and delicate they may be, while no skill whatever is required to use it. The machine consists simply of two gears, having a ratio of about 4 or 6 to 1, according to the size of the tap. The gear is mounted on an outboard bearing and meshes with the pinion which is fastened to the end of the shaft carrying the tap in a small chuck. A handle is fitted to the driving gear, and it has been found that the operator has not sufficient strength to break the tap by turning on the handle. If the taps used are very delicate it may be necessary to increase the gear ratio to 8 to 1, or more, but a point will soon be found where it will be impossible to break the taps. I have found this device to work very satisfactorily for tapping No. 1-60 holes in brass, which is considered an unusually severe test on a tap.



A Safety Tapping Device.

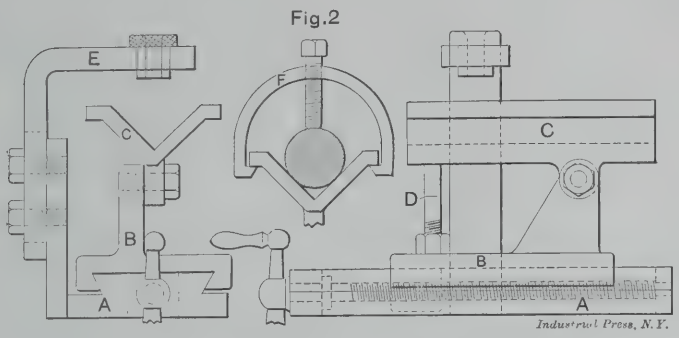
The taps, which are made as shown in Fig. 2, have a slight taper each way leaving only a short distance of their length the full size. The object of tapering the rear end is to relieve the strain on the tap and still have sufficient thread to feed it back if it is run way through the hole. In making the flutes I leave the threads quite narrow and back them off so as to leave very sharp cutting edges. Of course a tap made in this way will not last as long as one made in the usual manner, but it will do much better work with less danger of breaking. F. G. Davidson.

Brooklyn, N. Y.

A HANDY DRILLING FIXTURE.

Editor Machinery:

In a shop in which I was once employed we had in use a V-block which proved to be of the greatest convenience for drilling shafts, spindles or other round pieces. The base *A* was dovetailed and fitted with a lead screw which moved the slide *B* in and out under the drilling arm. Upon this slide was mounted the adjustable V-block *C*, which could be tipped at any desired angle for oblique drilling or set perpendicularly to hold the shafts in position for end drilling. The adjustable stud *D* was placed under the outer end of the block to hold it firmly in any set position. The drill arm *E* was adjustable up and down, for different sized shafts, and was supplied with a complete set of bushings for use with drills of different diameters. When mortising spindles for facers, boring bars, etc., the work was clamped into the V with the clamp *F*, shown in Fig. 2, then, after the first hole had been drilled, the slide was moved along for a distance equal to the diameter of the drill and the next hole drilled, and so on. By this method any number of holes could be drilled in perfect line and always through the center of the bar. By the use of a stop clamped across the end of the slide, the attachment formed a jig which could be used for a great variety of duplicate drilling. Roy W. Harris.



Adjustable Drilling Fixture.

Salem, Ohio.

PUNCH AND DIE FOR PERFORMING SIX OPERATIONS SIMULTANEOUSLY.

Editor Machinery:

A very interesting job of punch and die work which recently came to my notice was the production of small metallic caps such as are shown at *H* in Fig. 1. These were made from brass about .032 inch in thickness and to produce a finished cap six operations were required. The punch and die by which they were made were so arranged as to perform all six operations simultaneously and thus turn out a finished cap at each stroke of the press. Fig. 2 shows the combined blanking and drawing punch, the letters on each punch corresponding with the primed letters used in Fig. 1, to denote the different operations. Fig. 3 shows the die in section and plan.

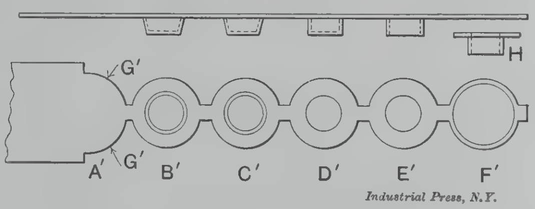


Fig. 1. The Work as Punched.

The strip of stock is fed under the punches *A*, *A*, and the end of it is cut by the front end of the punches into the semicircular form shown at *A′*, Fig. 1. For the second operation this round end of the strip is pushed ahead until the points *G′*, *G′*, come against the pins *G*, *G* (Fig. 3) which are set in the face of the die. This locates the blank in position for the first drawing which is performed by the punch *B*. At the same time that the drawing is being done, the punches *A*, *A*, are cutting the next section so that it may be gaged by the pins *G G*. To insure these punches cutting all the stock around the semi-circle, each side is extended 1-32 inch beyond the center of the circle so that the cuts overlap. All of the stock which they remove is pushed through the die and falls to the floor or into a scrap box.

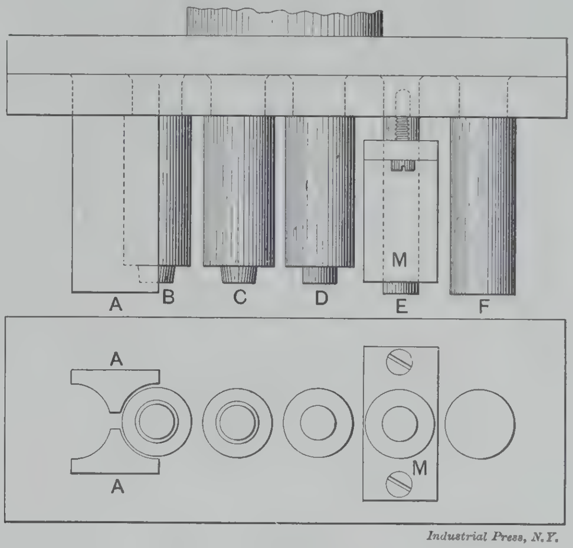


Fig. 2. Punch for six Simultaneous Operations.

The next two strokes of the press continue the drawing as shown at *C′* and *D′*, after which the cap is ready to be punched. This is done by the punch *E*, which is provided with an additional stripper *M* to prevent the punch from sticking to the cap, and raising it from the die, on the return stroke. The die *K*, is made of a hardened steel ring that is fitted snugly in its seat and is held in place by the ring *L;* both rings being easily removed when it is necessary to grind the die. The last operation which is performed by the punch *F*, consists in cutting the now completed cap from the strip of stock. From this operation the finished cap falls, through the bottom of the die, into a box; while the refuse stock issues from the machine in a string of rings as shown at *F′*. Toolmaker.

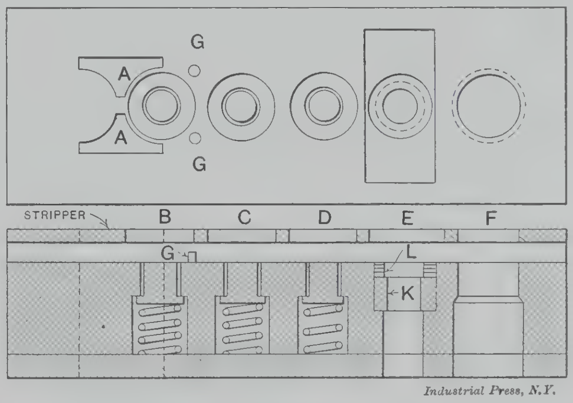


Fig. 3. Die for six Simultaneous Operations.

WHERE SHALL THE BREAK COME?

Editor Machinery:

There is one point in the design of any machine tool or mechanical construction that is often, if not generally, neglected. This is the consideration of making one place or piece in the construction of much less strength than the other parts. Every machine is liable, at some time or other, to be subjected to a shock or load that is far in excess of any for which it was designed. When this occurs something will have to break and it seems that it is just as much a part of good designing to provide for this breaking point as for any other feature in the design. If, after the parts of the machine are calculated for all allowable loads, a factor of safety is added for excessive loading, one part should be given a much lower margin of safety than the others, and this part should be one which will be the least expensive and cause the least delay in replacing. One or two cases that have lately come to the writer's notice will serve to illustrate the importance of this point in machine designing.

The first case was that of two power presses, of the beam type, both of which were broken at about the same time. The break in both cases was caused by the die slipping out of place so that the punch came down onto the hard steel surface. It could not punch this, and as the presses had powerful drives something had to break. In the first press all the castings had been made strong enough for all ordinary purposes, and in order to make the press amply strong the connection pins had been made of unnecessary size. The consequence was that when the trouble came the frame was broken and the press was ruined. In the other case the connection pins, or one of them at least, was made only strong enough to stand a very slight overload, and when the accident happened one of these pins was immediately broken. It was a matter of less than an hour's work to replace this pin and the press was just as good as new.

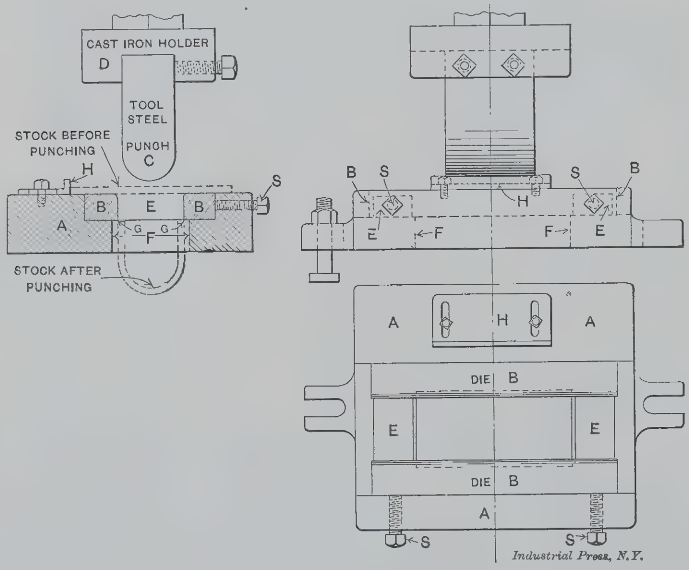
Another case came to notice when designing a large spur gear and pinion. The design, as first proposed, called for a cast iron gear and a steel pinion, and had the gear been designed to stand the required load the steel pinion would have been of about equal strength. In small tool designing this would have been considered very good practice but in this case it was considered advisable to reverse the arrangement somewhat. The pinion was made of cast iron and designed with a comparatively low factor of safety for the maximum load. The gear was also of cast iron but, having the same pitch and face, was consequently capable of carrying a much heavier load than the pinion. The combination as now installed provides for the worst possible accident to be the breaking of a small pinion, thereby saving the gear, which is 13 feet in diameter, and worth many times the value of the pinion.

GEO. FROST.

PUNCH AND DIE FOR FORMING RING OR TUBE IN TWO OPERATIONS.

Editor MACHINERY:

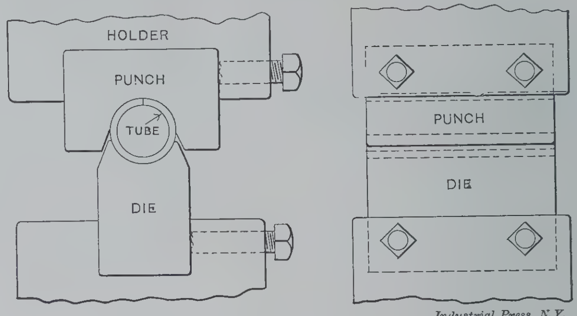
The accompanying sketches show the punches and dies that are used for making rings or tubes in but two operations. In usual practice this class of work requires three operations and the saving of one of these amounts to quite an item in time and expense.



Industrial Press, N.Y.

Fig. 1. First Operation for Forming the Ring.

The first operation is performed with the die shown in the cut, Fig. 1. Most diemakers insist that this die should be made out of a solid piece of steel, but I have made a number of dies in the way shown and they have all given perfect satisfaction. *A* is the cast iron holder having the opening *F*. The die consists of the pieces *BB*, which are simply two strips of steel, hardened and ground, that are kept in proper position by the cast iron spacers *EE*. Both dies and spacers are firmly clamped by two set screws *SS*. The spacers may be placed at any distance apart that the length of the die allows and thus a die can be formed for a ring ¼ inch wide or a tube 6 inches long. The action of this die will be clearly seen by reference to the cut. The stock, which is cut to length, is placed against the gage plate *H*, then the punch descends and pushes it through the die until it passes the points *GG*, which act as strippers on the return stroke.



Industrial Press, N.Y.

Fig. 2. Second Operation for Forming the Ring.

The second operation is accomplished with the very simple punch and die, shown in Fig. 2, which completely finishes the ring and thus dispenses with a third operation. After the blank leaves the first die it is in the shape of a U. The bottom of this is placed in the die, and as the punch descends the bevel, touching the upper edges of the U, gives them the required bend for entering the semicircle in the punch. The ring or tube is completed when the punch is at the end of the stroke.

G. D.

MAKING A HOLLOW SPINDLE LATHE.

Editor MACHINERY:

Every machinist knows the advantages which the hollow spindle lathe of to-day has over the old-fashioned lathe with solid spindle. In our shop we were in need of another hollow spindle lathe for a job upon which we were working, and as we had enough of these lathes for all ordinary work, we did not want to purchase a new one especially for this job. We had a solid spindle lathe that was in every other way suited to the work, so I undertook to transform it into a hollow spindle lathe in the following manner:

I first took the spindle out of the headstock and put it into another lathe on the head center and the steady rest. A hole was drilled about half way through it, from the back end, and a thread cut for a short distance on this end. It was then replaced in the headstock on the old lathe and a hole drilled in from the front end to meet that which was drilled before. Of course the two holes did not meet exactly, so an extension boring bar was used, and the full-sized hole drilled completely through the spindle. In place of the adjusting screw, on the end of the spindle, a washer about one-half inch was bored and threaded to fit the thread that had previously been cut on the end of the spindle. Spanner holes were drilled on the periphery of this washer so that it could be screwed up for adjustment, and the lathe was ready for use.

ROBERT B. OTIS.

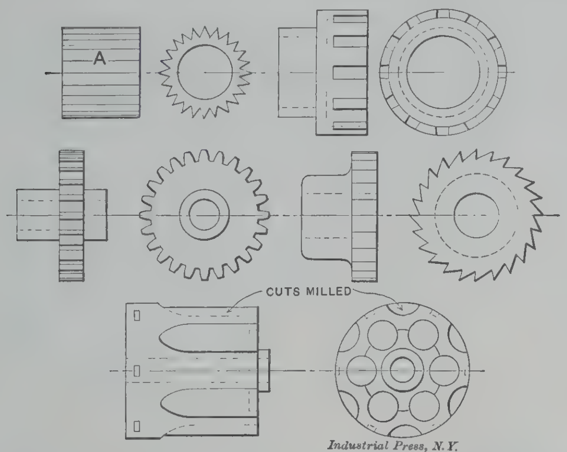
Orange, Conn.

AN AUTOMATIC MILLING MACHINE ATTACHMENT.

Editor MACHINERY:

The accompanying cuts illustrate a milling attachment that was made for automatically milling and indexing certain pieces of work, and while it may yet be farther improved it has so far proved very satisfactory for any of the work that it has had to do. Formerly an independent fixture was required for holding each piece of work to be milled, and one man or boy was required to tend each machine. With three or four of these automatic attachments an unlimited variety of work can be accomplished, and but one workman will be required to attend to the four machines. All that is necessary is to have a set of cams for each piece of work that is to be milled on the fixture. A variety of pieces of work that can be milled in this way is shown in Fig. 1, and in the illustration of the machine it is cammed for the piece that is marked

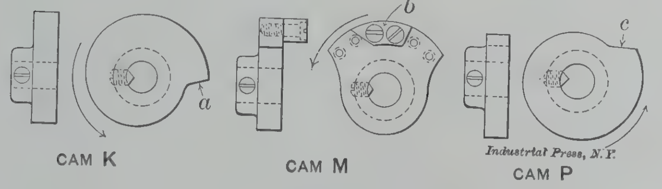
A in this figure. This piece, which is of steel, is 1 inch long and 1⅛ inches in diameter; it has a ¾-inch hole and twenty-four 60-degree teeth. This piece formerly gave considerable trouble, when it was milled with an ordinary fixture, as the bottom of the 60-degree cut was required to be as sharp as possible. With the old fixtures the operator used often to strike the work too suddenly, when starting a new cut, and in consequence the sharp points of the cutter were broken off and much delay caused by replacing the cutter and resetting the fixture. This led to the design of the automatic fixture and it proved so effective for this work that it was consigned to many other pieces, thus becoming a universal tool.



Industrial Press, N.Y.

Fig. 1. Some of the Work Milled with Automatic Attachment.

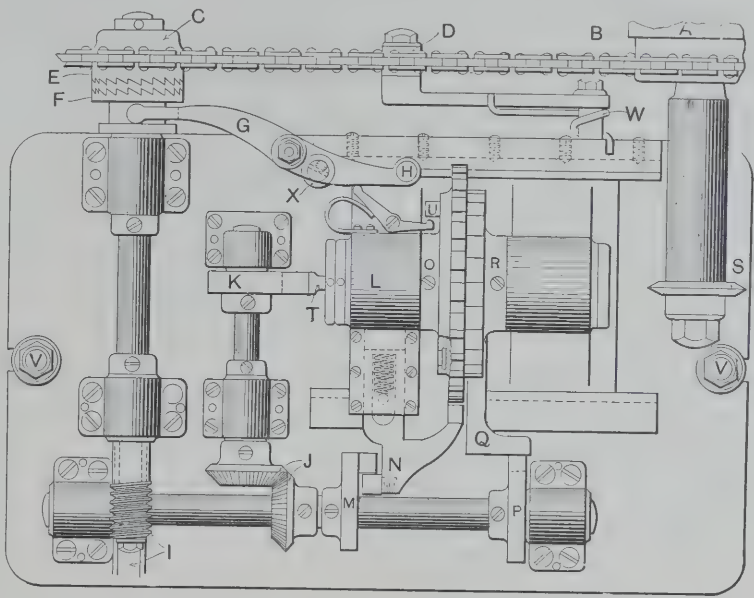
The three views of the attachment, shown in Fig. 2, will serve to make plain its construction and means of operation. It is placed upon the platen of the milling machine to which it is firmly clamped by means of the two bolts *VV*. The driving mechanism consists of a ¼-inch chain running from the 12-tooth sprocket, *B*, which is screwed on the spindle of the milling machine, to the 24-tooth sprocket on the driving shaft of the fixture. As it is necessary for the operator to run the platen away from the cutter a few inches when changing his work a stop is placed on the machine so that the platen can be brought back to its proper position before the cut is started. The extra length of chain that is therefore required is kept at the proper tension by means of the 8-tooth idler *D*, mounted upon a swinging arm, which is held against the slack side of the chain by the spring *W*. The sprocket *C*, having on its hub the clutch *E*, runs loose on the driving shaft. The clutch *F* is a sliding fit on this shaft and has a keyway which slides on a key fixed in the shaft so that when *F* is in contact with *E* the shaft is made to rotate.

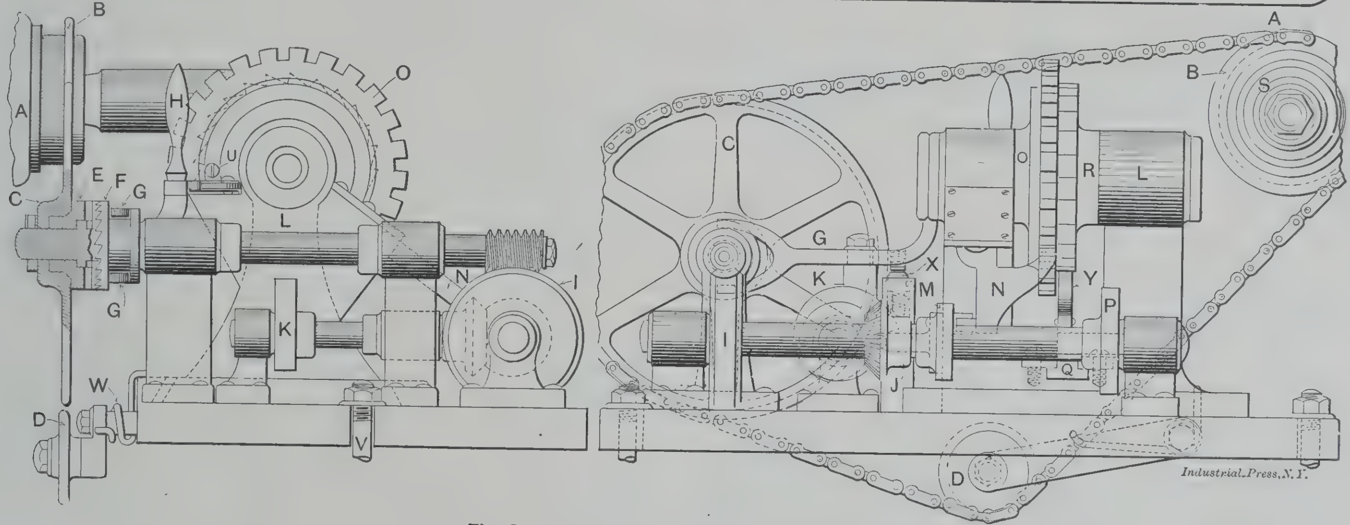


Industrial Press, N.Y.

Fig. 3. Detail of the Cams.

Upon the outer end of the driving shaft is the worm *I*, which drives the worm wheel of 41 teeth that is keyed to the cam-shaft. The milling machine spindle runs at 248 revolutions per minute; this speed is reduced to 124 by the sprocket ratio, and this further reduced, by the worm ratio, to a speed of about 3 revolutions per minute for the cam-shaft, a ratio between the milling machine spindle and the cam-shaft of about 83 to 1. In other words with the milling machine running 248 revolutions per minute a cut is made upon the work every 20 seconds. When setting the fixture for shorter cuts a larger sprocket is placed on the milling machine spindle or a smaller one on the fixture so that the speed of the cam shaft will be greater. We have 12, 14, and 16-tooth sprockets to fit the spindle and 24, 20, 16 and 12-tooth sprockets to fit the fixture, so that we can obtain satisfactory speeds for all the pieces which we have to mill.





Industrial Press, N.Y.

Fig. 2. Automatic Milling Machine Attachment.

Upon the cam-shaft will be seen a pair of miter gears *J*, which are used to drive the shaft carrying the cam *K*, at the same speed as the main cam-shaft. This cam, which is shown in detail in Fig. 3, imparts the backward-and-forward motion to the indexing head, *L*, which is dovetailed and gibbed to slide upon the base of the fixture. A spiral spring, not shown in the drawing, keeps the head always in contact with this cam. The throw of the cam is determined by the length of the slot or groove that is to be milled and the angle *a* is such that the cam finger *T* will drop back without jar and allow the head to slide back with a quick and easy motion.

Next, upon the cam shaft is the cam *M* which pulls the index finger *N* out of the index plate and holds it long enough for the cam *P* to push the head around to the required division. The piece *b*, Fig. 3, is practically the cam and the body *M* is never taken from the shaft. For obtaining changes in the length of time that the cam holds the pin out of the plate, different pieces are fastened on in the place of the one shown. Six tapped holes are provided for this purpose so that cam pieces of almost any length may be attached.

The piece *Q* is a slide to which is fastened the pawl *Y*. This slide is held against the cam *P* by a spiral spring and the pawl engages the ratchet disk *R*, and so moves the head around for the number of teeth required. Both indexing plate *O* and ratchet *R*, have 24 teeth so that 2, 3, 4, 6, 8, 12 or 24 divisions may be obtained. The throw of the cam *P* depends upon the number of divisions that the ratchet plate is to be turned. *c*, on this cam, is a sharp slide so that the throw takes place quickly, after which the cam carries the pawl gradually back into position for the next indexing. At the end of one complete revolution of the indexing head the pin *U* strikes against a small bell crank and throws the lever so as to disengage the clutch *F*, thereby allowing the clutch *E* and the sprocket *C* to run loosely on the driving shaft until the machine is again started by throwing the lever back so as to re-engage the driving clutch. A quick movement is given to this lever by means of a spiral spring under the stud *X*, as will be seen in the front view in Fig. 2. At its top this stud is beveled off on two sides, so as to make a point of about 90 degrees and this bears against a similar stud screwed into the under side of the lever. Besides imparting a quick motion to the lever, these studs tend to keep the clutches in or out of engagement. The stop *U* can be adjusted to any point as it is held in a circular T slot which extends completely around the plate.

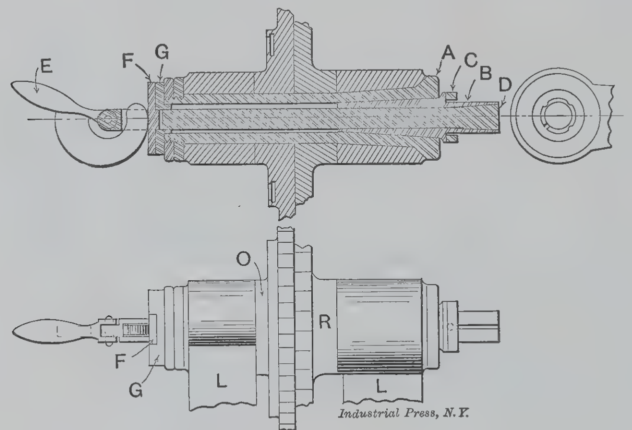


Fig. 4 Expansion Arbor used with Milling Attachment.

Each set of cams is marked for the particular piece for which they are adapted; on cam *K* is also marked the number of teeth in the sprockets that are to be used on both the milling spindle and the driving shaft of the fixture; while on the cam *P* is marked the depth of the cut that is to be milled in the work. A special arbor to hold the milling cutters is made for each job and the cutter is located on the arbor at a certain distance from the sprocket on the spindle so that by centering the fixture with the cutter the sprockets will come in line.

The work is held on a quick-acting expansion arbor which is shown in detail in Fig. 4. The piece to be milled is placed upon the split bushing *B* which is tightened in the hole by a movement of the lever *E*, that pulls back the spindle *D* and expands the bushing. A collar *C* is fastened to the chuck so that the slots in the bushing can be run beyond the shoulder against which the work bears, and a more effective expansion is thus secured. This fixture may be used on any style of milling machine and should there be no thread on the spindle to receive the sprocket *B*, it may be placed on the arbor as near to the spindle as convenient. Jos. M. Stabel.

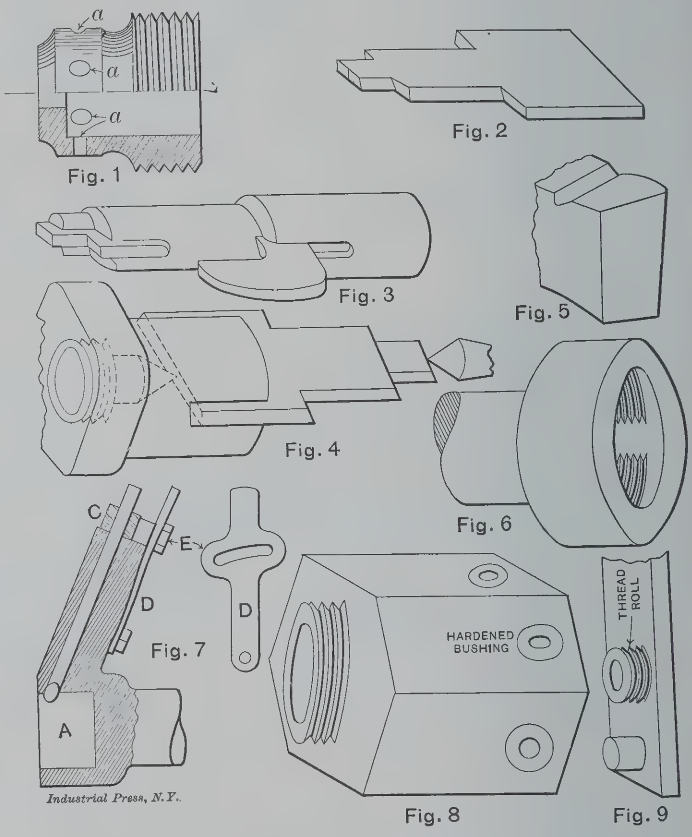
New Haven, Conn.

TOOLS FOR A BRASS PACKING GLAND.

Editor Machinery:

The tool maker had just been confronted with a new problem. A design called for a large number of pieces as shown in Fig. 1, and he was to make all necessary tools and the jig for drilling the holes *a*, *a*, *a*. The inside was plain, but as a good job was necessary, both a roughing and finishing tool were provided. The roughing tool was made from flat steel as shown at Fig. 2. The finishing tool, which is shown in Fig. 3, was provided with a milling wing for turning the body ready to thread, and this turning took place simultaneously with the finish boring.

For those who are not familiar with flat cutters, it may be said that they are cheap, very efficient for roughing and, when thick enough, make good finishing tools. As may be imagined they are not very easy things to turn in a lathe, but the use of the little driving chuck shown in Fig. 4 makes it much easier. This chuck screws onto the spindle, in the usual manner, and when turning a flat cutter, it is simply centered like a round piece and put into the slot in the chuck and between the centers as shown in the cut. Do not expect a diamond-pointed tool to stand this kind of work, however, or you will be disappointed. Use a round-nose side tool for roughing, and then for finishing, the *side* of a diamond-pointed tool may be used, although a tool something like that shown in Fig. 5 will be found very satisfactory. This sort of work is very hard on a lathe as there is a shock, equivalent to an upward blow on the centers, twice to each revolution.



Tools for Machining a Brass Packing Gland.

The milling cutter being on the finishing bar insures the outside being true with the inside, and it should be fed very slowly into the work. For very exact work, it would probably have been better to have used two bars with a wing milling cutter on each, instead of roughing with a flat cutter, but in this case the flat cutter was all right. To make sure that the work entered the die truly, the thread was cut away from the mouth as shown in Fig. 6. This could not be done in all cases, but worked very well in this one as there was plenty of room.

These tools completed the first operation, and the threaded end was then held in a screw chuck while the other end was being finished. This was accomplished by using a wing milling tool, similar to that used for the other end, with a plain bar that entered the hole before the cutter began to work. This gave a guide for the milling tool, held it to its work and left the piece ready for necking with the tool shown in Fig. 7. This tool was bored out at *A* to fit the finished end of the gland while a piece of ⅜-inch drill rod, sliding through a hole in the oblique arm, was ground at its lower end to cut the neck to its proper shape. The clamp *C* was fastened to the rod while one side had a flange into which was set the bolt *E* that worked in an eccentric slot in the lever *D*, fastened onto the back of the oblique arm. When the lever was in its uppermost position the tool was slipped over the end of the gland and a pull on the lever then forced the cutting rod down and formed the groove.

The jig for drilling the holes was a simple affair, which is shown in Fig. 8 with one of the pieces in position. It was found that the burr raised by the drill made it almost impossible to get the piece out after it had been drilled, as there was nothing but the threaded end to get hold of. After a little thought the wrench shown in Fig. 9 was made. It consisted of a flat piece of steel with a short pin in the end. At the proper distance from this was a soft steel roll cut with a thread like that on the work and loose enough to turn freely. All that was necessary was to slip this over the end of the work, swing it into the thread and it formed a powerful lever with which the work could be easily removed.

While it is not likely that any one who reads this will have a job exactly like it, yet there are several points that can be adapted in many places. FRED H. COLVIN.

New York, N. Y.

HIGH-SPEED HELICAL GEARS.

Editor MACHINERY:

The matter of high-speed gearing has occupied the attention of the best engineers for a number of years. More or less success has been obtained in this line by the substitution of a softer material in place of the metal generally used, such as leather, fiber, and rawhide. When the power transmitted is very light, this form will often prove satisfactory. The principal trouble with this soft material is the lack of proper tensile strength when subjected to heavy strain or sudden shocks. This is partially overcome by increasing the face of the material from 33 to 50 per cent. over what would be used for gears made of cast iron, but this is not always admissible. There are also many other reasons why this material is objectionable. It is usually affected greatly by the weather and temperature, which increase or decrease the diameter very noticeably and also warp the gear blank out of its true form. In addition to this, when it is necessary to use small pinions, the stock between the bottom of the cuts and the hole is not sufficient for ordinary duty. The cost of making gears of this material is considerably more for material and labor than for ordinary metal gears.

The use of metal gears with helical form of teeth is now commanding a great deal of attention, and, in many cases, they have proved to be eminently successful. For shafts running at right angles and not in the same plane, the ordinary form of "spiral gears" is illustrated by Fig. 1. This represents a pair of spiral gears with speed reduction of about 3 to 2, teeth cut left hand, 45 degree angle. Inasmuch as spiral gears are, in reality, a special form of worm and worm gears, with many threads in the worm, it is obvious that the driver or worm can be most any convenient size without changing the speed reduction. This peculiarity proves to be a great advantage in designing machines where the economy of space is an object, and this form of gear is used to considerable extent in many of the latest machines. This style, with shafts at right angles, creates more friction than the ordinary form of gears; consequently it should be used only for ordinary speeds and power, and is generally provided with good thrust bearings to take up the end strain on the shafts, thereby reducing the friction on the gear.

If this special gear is properly designed, and made by one experienced in this line of gears, very wonderful results can be obtained and will establish the fact that its use is almost unlimited. This is verified by the use of same in most all up-to-date machines. Modern gear machine manufacturers use it almost wholly for the cutter drive. It is also used quite extensively in automatic machines, drill presses, etc. For heavy work, the gears should be run in a bath of heavy cylinder oil. For high speed and light power they are also used extensively for the best form of blacksmiths' blowers, such as the Champion blower, and are also used by the best makers of centrifugal cream separators, such as are made by the Burrell Mfg. Co. A speed of 10,000 to 20,000 revolutions is maintained with best results, making little or no noise and exhibiting wonderful durability. We believe this form of gearing can be run at as high a speed as 30,000 revolutions, if properly constructed.

For parallel shafts, a form of double helical spur gear is represented by Fig. 2. These are generally called "herringbone" gears. The single form, usually called "helical spurs," is illustrated by Fig. 3. Formerly, this style of gear was cut with the teeth at an angle of 45 degrees, but this is found to be unnecessary, as much better results are obtained with teeth cut on an average of from 10 to 20 degree angle. The cuts represent teeth cut on an angle of about 15 degrees. The correct angle is determined by the face and pitch. All that is necessary is that the angle be sufficient so that the tooth at one side is opposite the adjacent space at the other side of the face of the gear, or, if anything, a trifle more angle is preferred. Too much angle causes unnecessary thrust which would be particularly noticeable in the single form. (Fig. 3.) There is also less contact of tooth where the angle is great than where small, as the tooth contact at 45 degree angle or more will be that of a point only, whereas the contact at a smaller angle approaches that of a line, as in ordinary spur gears, thus giving a greater bearing surface for strength and durability.

In most cases the single form will prove quite satisfactory. For severe duty and very high speed the best results, however, are obtained by the use of the double or herringbone form of gear, as there is no end thrust on the shafts because one set counterbalances the other. The gears, when placed together, should have the teeth staggered, so that the teeth of one set of gears are opposite the spaces of the adjacent gears. Placed in this way, we gain the same advantage, while using a coarser pitch for strength, as if the teeth were cut much finer, as there will be more teeth in mesh at a time than if teeth were placed opposite teeth. This will be particularly advantageous where there is a small number of teeth in the pinion. The edges of the teeth, where the two halves touch, should be turned off slightly to avoid interference at the corners. (See Fig. 2.)

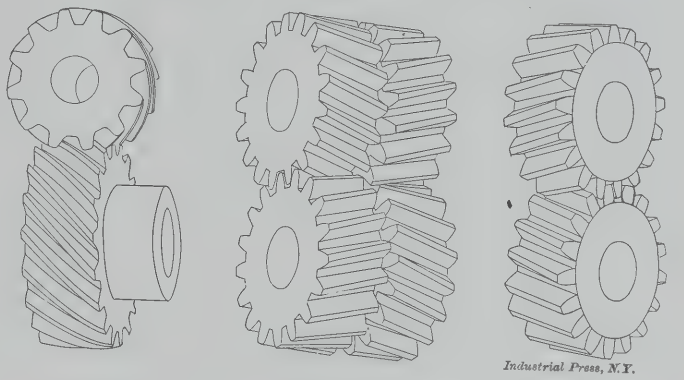

Industrial Press, N.Y.

Fig. 1. Fig. 2. Fig. 3.

High-speed Helical Gears.

Unless the gears are cut very accurately, this helical form will be of no special advantage over the ordinary spur gear style. Ordinary milling machine heads, with index of 3 to 4 inches diameter, will usually not be accurate enough for spacing this style of gearing, as the object to be gained—that is, silent running gears—will be defeated unless the spacing is exceptionally accurate. Special machinery for cutting with great accuracy of spacing is absolutely necessary for best results. Selecting or designing cutters for this purpose, of correct curve or pitch, also requires unusual care. Under proper conditions of cutting and mounting gears of this style, they can be very often run at a speed of from 1,500 to 3,000 revolutions, with very little or no noise. We believe it safe to predict that inside of ten years, all up-to-date machines will be made with spur gears of helical form of tooth. In lathes, milling machines and other tools they will have the great advantage of not only running smoothly and quietly, but will permit better approach of tools to the work than would be the case if ordinary clattering spur gears were used. The worm gear drive of the Sellers planer and of other makers has already proved the desirability of such a drive over the ordinary spur gear.

The French people hold the honor of the greatest advance in this line, in using bevel gears with curved teeth in place of the ordinary straight planed teeth, and there is no doubt, after the helical spur gear style has been thoroughly adopted, that the bevel gear will follow in line. FRANK BURGESS.

Boston, Mass.

BRASS WORKING TOOLS.

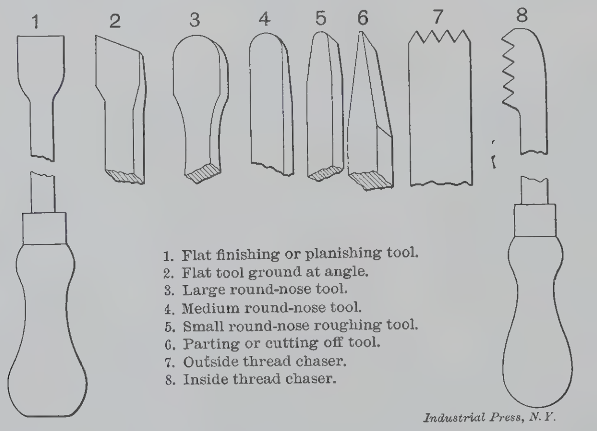
Editor MACHINERY:

When a little brass work is to be done in the average machine shop, it is naturally handled in the same manner as iron. The result is not always satisfactory either to the workman or to the employer when he comes to pay the bill, and the mode of procedure would make a Fox lathe-man have heart failure. Anything between the various mixtures of lead, tin, copper and other metals and the old "six of copper, one of tin" alloy is called brass, but that usually found contains just as little copper and tin as possible, as they are the costly ingredients. Pure copper is not a nice metal to turn, as it comes off in shavings more like wrought iron than any of the softer mixtures. These fly off in chips, which seem red hot when they strike the arm or the face.

Brass work is generally held in a two, three or four jaw chuck, or on a screw chuck which holds one end of the piece that has been previously threaded for it. It is seldom held between centers, so that the back head or tailstock is left free, and in the Fox lathes this is provided with a cross feed movement similar to the cross feed on the tool post of an engine lathe. This and the movement of the spindle give the operator a wide field of operation when carrying the proper tools in the tailstock.

Beginning with hand work we have an array of tools like those shown in Fig. 1. For roughing out work or getting under the scale of the casting a small round-nose tool like No. 5 is generally used, while Nos. 3 and 4 are for finishing in round corners or roughing concave surfaces. After roughing, the flat portions are smoothed down with flat tools or planishers whose width and shape depend on the idea of the workman. These are also used in making any convex surface.

Cutting off is done with a tool like No. 6, which is often called a parting tool. None of these tools have any top rake, as with iron and steel tools, but are often ground off the other way. When carefully ground and whetted on an oil stone they will do lots of hard work, and do it smoothly. Roughing tools need not be whetted, but may be used as ground. Chasers are shown by Nos. 7 and 8, which are respectively for outside and inside work. It is quite a trick to start a true thread with these tools, but the easiest thing in the world to make a "drunken" thread, or one which does not follow a true incline, having one or more sudden jumps in it. Comparatively few men nowadays have occasion to chase a thread, or could do it without numerous failures, but for repair work or cleaning up threads these chasers are very handy.

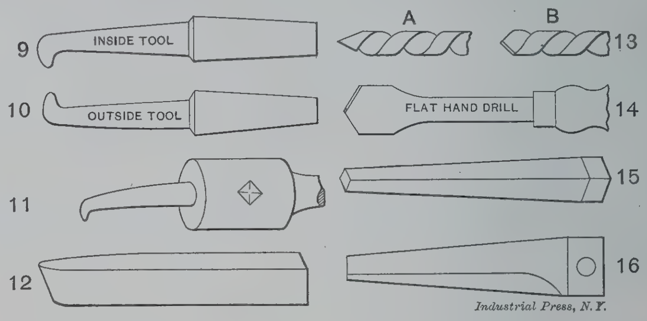


1. Flat finishing or planishing tool.
2. Flat tool ground at angle.
3. Large round-nose tool.
4. Medium round-nose tool.
5. Small round-nose roughing tool.
6. Parting or cutting off tool.
7. Outside thread chaser.
8. Inside thread chaser.

Industrial Press, N.Y.

Fig. 1. Brass Working Hand Tools.

As most of the work of this class is done on the engine or Fox lathe, the tools used will be considered. The back head uses a hook tool, similar to Nos. 9, 10 and 11, which closely resemble regular inside tools, except that the point is turned the other way for outside work. Sometimes a tool holder, as shown by No. 11, is used with small inserted tools. Slide rests are to the Fox lathe what the tool carriage is to the engine lathe and the tools are similar in form except as to size and the shape of the cutting edges. There must be no top rake or the tool will dig in badly, it being remembered that the work is held in a chuck with the outer end unsupported. By giving the tool no top rake, or even grinding down a little, all difficulty of this kind is avoided and the tool cuts just as well, to all appearances.



Industrial Press, N.Y.

Fig. 2. Brass Working Machine Tools.

Drills, also, require special treatment if trouble is to be avoided. The twist drill as it comes from the factory or as it is used in iron is very apt to "draw into" a hole in brass or to pull through if it breaks through a piece of work. This is due to the lead on the lips. By grinding this off a little, as indicated at *B*, No. 13, Fig. 2, this trouble is avoided. On small drills it is sometimes found best to grind the whole point flat, as shown at *A* in the same figure.

For rough boring tools in a solid piece, such as an injector tube, most workmen prefer a flat hand drill, as shown by No. 14. A series of these are used for taper holes, the larger being used first and the others following to the proper depth to make about the required taper. This is then reamed out to the exact taper with various tools. A flat reamer is often employed with good results, especially for roughing. For finishing it is very apt to chatter unless packed on each side with a piece of hard wood of about the right shape to conform to the hole. Sometimes a reamer with a single large flute, as shown at No. 16, is used with good results. It is relieved nearly all the way around. For finishing, it is hard to beat the old square reamer, as shown at No. 15. This reams a nice smooth hole as it fills up with chips enough to prevent chattering, and it starts well if carefully ground and honed on an oil stone.

In this connection it may not be amiss to call attention to the too frequent misuse of the oil stone on tools of all kinds. I have seen men spend much time in carefully grinding a tool and then spoil it with an oil stone, literally destroying the edge they had obtained by grinding. Others laugh at stoning as a waste of time, but I do not agree with them, provided the stoning is properly done. Grinding trues up the cutting edge and makes it sharp, but it also throws up a rough wire edge, which does not produce good work. The oil stone, carefully applied, will remove this wire edge and not destroy the cutting edge; in fact it makes it sharper for clean cutting by removing the rough portions which are in the way.

BRASSWORKER.

FOREIGN COMPETITION.

Editor MACHINERY:

Of late we have heard a great deal about the foreign machinery market. In my observation of machinery trade in Europe I have noticed that machinery of nearly every description is higher in price than in the United States, and at present the Yankees need be afraid of no intrusion on their markets of foreign machinery.

The price of good malleable iron and steel is higher here than in the States, and although labor is cheaper, the workmen are not as efficient. It is my opinion that a better quality of work for the same price can be produced in the States. Throughout Europe good material for manufacturing is higher, and manufacturers, as a rule, make too many kinds of machines to obtain efficiency in any particular branch. Take for instance farm implements. Every manufacturer of any note tries to make all kinds of machinery belonging to that line; harrows, rakes, plows, etc., are also made by country blacksmiths. At a fair last summer I saw a great many imitations of American rakes, reapers and mowers, but they were poor imitations, indeed. The cause of this was unskilled workmanship. The manufacture of farm implements here now is about the same as it was thirty years ago in the States. They are just beginning to use special jigs and fixtures. As a rule their products on the interchangeable plan do not fit as well as ours. I know of one large factory here that cannot supply extras without having the worn-out part so as to be sure of the kind, style and size wanted. They seem to manufacture without any regular system. Not until the European manufacturers use the same methods, or those as good, as the Americans, can they compete with them in trade. As a rule the Yankee manufacturer uses machinery and special jigs and fixtures to accomplish his work to a far greater extent than any of his competitors. In this country there is much hand-labor employed. The American has made rapid production and duplicate parts a study. He has gone at it in a businesslike manner to systematize his tools and equipments. The reason of this is the sharp competition at home and a fight for supremacy abroad. Although the manufacturer may have studied his business, and knows it well, he could not have achieved such a high standard in the business world were it not that men employed read more, study more and work harder than their foreign brothers. The American workman generally takes one or more papers pertaining to his trade, but owing to the low wages and the comparative high price of such papers the German workman cannot afford this luxury; furthermore, they are not published so that men with an ordinary education can read and understand them. This is another drawback to the manufacturer. It is the systematic co-operation between manufacturers and workmen that has helped to bring America into the foremost rank of the nations, and this is what Germany and other European nations need. Were German manufacturing systems as well organized as their military system then might America have greater cause to fear this foreign competitor.

A. J. DINKEL.

Neubrandenburg, Germany.

* * *

The *Engineering News* in an editorial on dynamite and the dangers attendant to its use, points out that by far the greater number of accidents occuring in the use of this highly dangerous explosive, are caused by freezing and subsequent thawing. There are now a number of safety powders of high power on the market which do not freeze and which cannot be detonated by mechanical shock. These safety powders now cost no more than dynamite, are of practically equal power and do not deteriorate with age, or at least not so quickly as dynamite. The disastrous accidents that have occurred on the railroads have led the D. L. & W. and N. Y., N. H. & H. railroads to refuse to carry it as freight, and should other roads also put a ban on it, as they probably will, the time is not far distant when dynamite will be unobtainable except in the immediate vicinity of the factories. In view of these conditions the indications are that the use of dynamite will eventually be abandoned. Let us hope so.

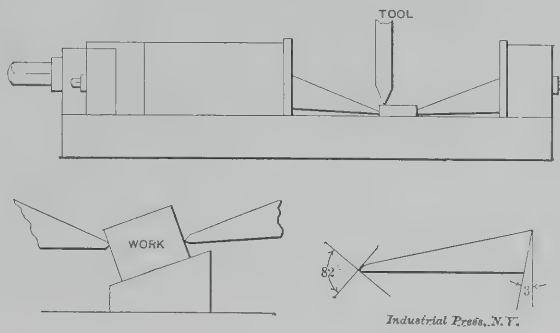
* * *

On the roof of the Western Union Telegraph building in lower New York, there is a steel tower 105 feet high which carries at the top a pole down which a time ball drops 25 feet at exactly 12 o'clock, noon, every day. The ball, according to the *Electrical Review*, consists of a framework of brass rods bent into spherical shape and covered with stout canvas. The ball is dropped by an electrical impulse sent from Washington and the instant the ball reaches the base of the pole the fact is automatically communicated back to Washington through an electric tell-tale. The noon signal is transmitted from New York by a bank of relays to 142 circuits connecting all the principal cities and towns throughout the country. In New York City alone 1,450 clocks are synchronized from the Western Union office and 150 in Brooklyn.

CONTRIBUTED NOTES AND SHOP KINKS.

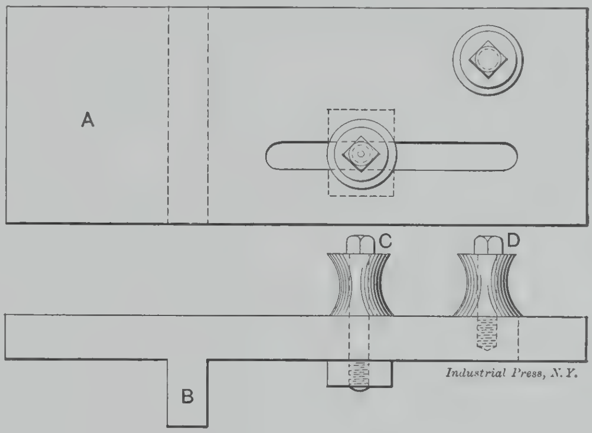
CLAMPING STRIPS FOR SHAPER VISES.

"Shaper" sends a sketch of an improved form of clamping strip for use in holding work in the shaper vise. When the vise jaws clamp the strips, the bases, which make an angle of about 3 degrees with the lower sides, naturally adjust themselves to a position parallel to the vise jaws and cause the points, which are about 1-16 inch wide and pointed to 82 degrees, to bite in and press downward on the work, thus holding it true to the bottom of the vise or to any beveled parallel, or other piece, that may be placed under it. These strips should be of steel, hardened and ground.



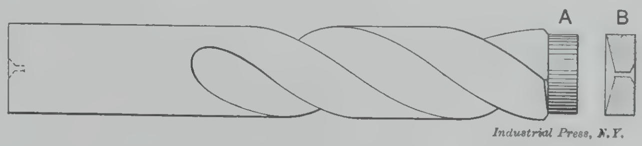
A PIPE BENDING RIG.

Geo. I. Babcock, Providence, R. I., sends a "kink" for a pipe-bending rig that is shown in the sketch. The plate *A* has on its under side a rib *B*, by means of which it is held in a vise when in use. This plate is fitted with two cast iron rolls. *C* and *D*, around which the pipe is bent. *D* is permanently fixed in place but the stud by which *C* is fastened slides in a slot in the plate and can be adjusted to suit the size of pipe and the radius to which it is being bent. By placing marks on the plate any number of plates can be bent to the same curves.



GRINDING A TWIST DRILL.

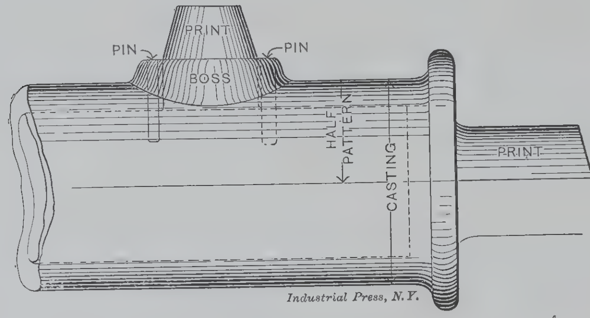
It very often happens that, for some reason or other, a twist drill has to be reduced in diameter on the grinder, and as there is no center hole in the end, this is a rather difficult job. Charles P. Thiel, Lawrence, Mass., sends a description of his method of doing this, which is inexpensive and, he says, capable of producing a very good job. The "kink" consists in soldering onto the end of the drill a small brass disk, as shown at *A* in the sketch. A section through this disk is shown at *B*. He first takes a bar of brass, slightly less in diameter than that of the drill to be reduced, and in the end drills a small hole. Then the drill that is to be ground is started into the same end of the bar sufficiently deep to cut a seat that exactly fits the point of the drill. The end of the



bar is now cut off and the disk is ready for soldering. There is no danger of drawing the temper of the drill if care is taken in doing this. To do it properly a soft solder should be used and the point of the drill tinned with the soldering iron. The small hole in the disk is then plugged up with wood and the cup-shaped depression filled with solder. The drill is placed into this and held there just long enough for the solder to set sufficiently to allow the drill to be lifted up and both drill and disk plunged into water. The drill is then trued up by scraping the center.

LOOSE BOSSES ON A PATTERN.

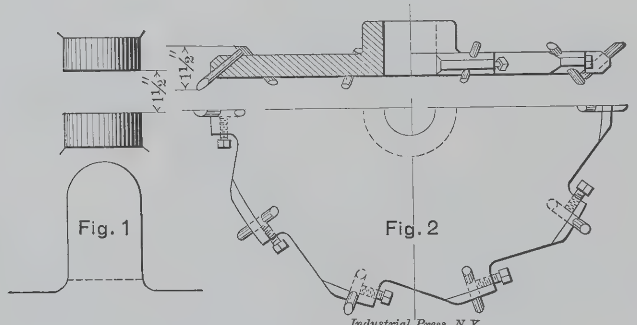
R. sends in the following kink: The sketch shows a small pattern which was to be made on a molding machine. The size and shape "cut no figure;" what I want to speak of is the boss shown in the sketch. A one-half pattern was used and the boss cast on one side only. After one half was made with the boss on, the boss was taken off and the other half made. In putting the boss on, the patternmaker did so with small wire pins so that it would lift off in the mold. The foreman saw this and told the patternmaker to make dowel pins just tight enough so that boss would remain on the pattern after the mold was lifted off. The reason for this was: It was much easier to pick the boss off the pattern than to pick it out of the mold and in a short time destroy the boss with a lifting pin.



Industrial Press, N. Y.

A SPECIAL INSERTED TOOTH MILLING CUTTER.

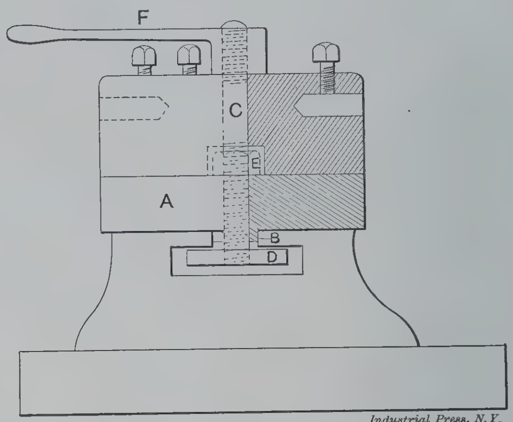
Erine Falkenrath, Racine, Wis., sends the sketch of an inserted tooth milling cutter of simple construction that was found very efficient for a job which could not be done on the planer. On the piece to be machined were a number of tall lugs (Fig. 1) which were to be finished on the inside, 1½ inches from side to side. A jig was made for holding the pieces on the vertical miller and the lugs were machined with the cutter shown in Fig. 2. The body of this cutter was of cast iron and the teeth of Stubs steel held in place by means of set screws. The peculiar feature about the cutter was the arrangement of the teeth which were placed alternately, right and left, so as to form a two-sided cutter with which the slots were milled to an accurate width.



Industrial Press, N. Y.

A TOOL POST TURRET.

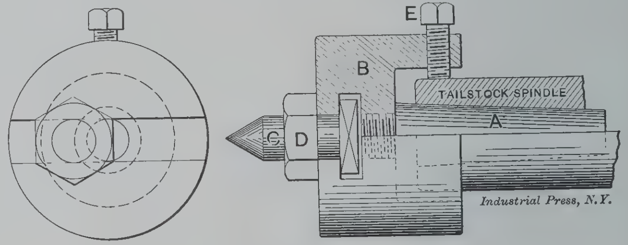
Robert B. Westover, Amherst, N. S., sends the sketch of a tool post turret which is easily constructed and in many cases, on small work, answers every purpose of a regular turret. The base *A*, which is of the same diameter as the turret head, has on its lower side a tongue *B*, which fits into the T slot of the tool post and prevents the turret from turning on the post. Through the center of the base passes the stud *C* having a square head plate *D* and the binding nut *E*. When this nut is screwed down the plate is firmly fastened to the tool post. The turret head revolves around the stud *C*, and is counterbored on the bottom to clear the binding nut. The turret is made of cast iron and is provided with six or more holes for the tools which are held in place by means of set screws. The indexing is done by hand and the head clamped by the lever nut *F*.



Industrial Press, N. Y.

AN OFF-SET CENTER.

When one has a sharp taper to turn it frequently happens that the tailstock cannot be off-set sufficiently, or the tailstock of any lathe available may not be arranged to set over at all. In such a case the off-set center, a sketch of which, sent by M. H. Westbrook, Stratford, Ont., and shown below, may be used very satisfactorily. This center consists of the shank A, which replaces the regular dead center in the tailstock. Onto this is screwed the sleeve, *B*, which has a T-slot extending across its face. The adjustable center *C* can be set at any point in this slot and is held in place by the clamp nut, *D*. The set screw *E*, clamps the tailstock sleeve and thus prevents the arrangement from turning.



Industrial Press, N. Y.

* * *

To successfully coat with tin, the castings must be absolutely clean and free from sand and oxide. They are usually freed from imbedded sand in a rattler or tumbling box, which also tends to close the surface grain and give the articles a smooth metallic face. The articles are then placed in a hot pickle of 1 part of hydrochloric acid to 4 parts of water, in which they are allowed to remain from one to two hours, or until the recesses are free from scale and sand. Spots may be removed by a scraper or wire brush. The castings are then washed in hot water and kept in clean hot water until ready to dip. For a flux, dip in a mixture composed of 4 parts of a saturated solution of sal ammoniac in water and 1 part hydrochloric acid, hot. Then dry the castings and dip them in the tin pot. The tin should be hot enough to quickly bring the castings to its own temperature when perfectly fluid, but not hot enough to quickly oxidize the surface of the tin. A sprinkling of pulverized sal ammoniac may be made on the surface of the tin or a little tallow or palm oil may be used to clear the surface and make the tinned work come out clear. Some operators again dip in a pot of hot palm oil or tallow at a temperature above that of the melted tin, for the purpose of draining the excess of tin and imparting a smooth, bright surface to the castings. As soon as the tin on the castings has chilled or set they should be washed in hot sal soda water and dried in sawdust.—*Metal Worker.*

SYSTEM OF CHUCKING CAR WHEELS FOR TURNING THE TIRES.

We have received from the Ateliers Demoor of Brussels, Belgium, matter descriptive of the L. Tricot system of chucking car wheels in lathes for turning the tires when the wheels are mounted on their axles. This system, which is also applicable to axles having outside cranks, is doubtless novel to those who are only familiar with the practice followed in American railway shops, and as it seems to possess features of considerable merit, it is briefly outlined in the following:

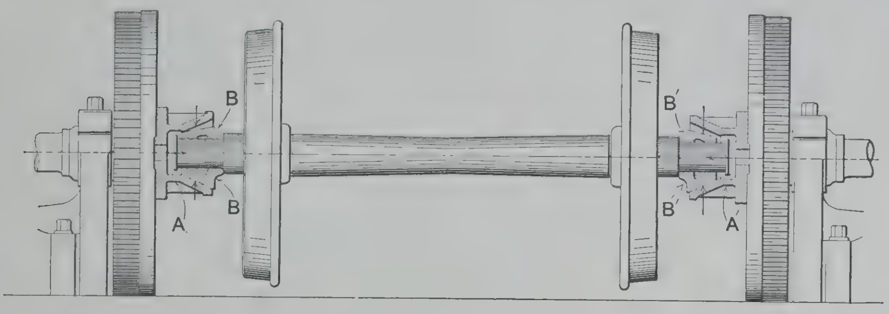


Fig. 1.

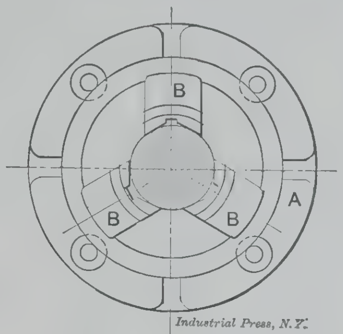


Fig. 2.

We will preface the description by remarking that in turning steel-tired car wheels mounted on their axles, one of the chief factors contributing to lack of rigidity of the work, which is so necessary to the maximum output, is the pointed poppets or centers on which the axles are "centered" in ordinary practice. These are unavoidably of comparatively weak construction and have a limited area of contact in the ends of the axles. The point of support is also some distance removed from the plane of the wheel so that the pressure of the cutting tool has a bending moment. Another fault inseparable from the system of turning tires with the axles suspended on centers, is that if the conical holes reamed in the ends of the axles are not perfectly concentric with the axle bearings, there will be a lack of truth in the turned wheels, that is, the tire periphery will be "out" with bearing surfaces. Of course when the axles are new, this defect cannot exist to any extent, but it may be present to a serious degree after an axle has been in use for some time without the bearings having been turned. Absolute concentricity of the tires and bearings is very necessary in high-speed trains. A representative of the firm has calculated that for a speed of 72 kilometers (45 miles per hour) the centrifugal force tending to produce a hammer-blow effect on the track, is 146 kilograms (321 pounds) for a pair of wheels one meter (39.37 inches) diameter, weighing 990 kilograms (1,980 pounds), and having an eccentricity of only one millimeter (.03937 inch).

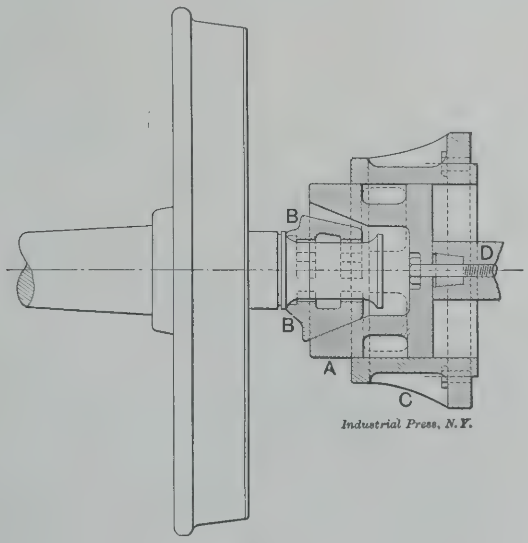


Fig. 3.

In the Ateliers-Demoor system the axles are gripped circumferentially on the bearings themselves by three jaws held in conical-mouthed chucks and pressed against the axle bearings by the resultant of the end pressure. This is illustrated in Fig. 1; and Fig. 2, of the same cut, shows an enlarged end view of one of the chucks. *A* is the chuck body and *B B B* are the three jaws. In this case, apparently, no provision is made for conveniently getting the wheels in and out of the lathe, it being necessary to move one of the headstocks a sufficient distance to clear. In Fig. 3, however, the way this difficulty may be obviated, is shown. A heavy piece *C* is bolted to the faceplate and bored cylindrically for the chuck-body *A*, which is adjustable longitudinally by means of the spindle *D*. The piece *C* solidly supports the chuck and at the same time affords clearance between the faceplates for the entering and removing of the wheels. Fig. 4 shows a special chuck employed for holding cranked axles. The construction of this form and its application, are evident from the cut.

The conical hole in the chucks made for this system, is bored to an angle of 22 degrees with the axis, making the included angle 44 degrees. The jaws are cut interiorly in open V-shape, the angle being 128 degrees. The jaws are, of course, made parallel with the axis on their inner faces so as to grip the bearing along their full length. The faces of the jaws being cut V-shape, grip the bearings at six points in its circumference so that there is little tendency to mar the surface. To entirely overcome any possibility of such action the bearings may be incased with strong paper or better, a thickness of sheet iron or tin, but in practice this has been found unnecessary.

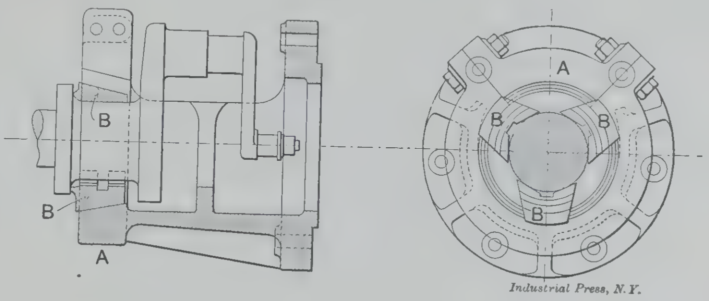


Fig. 4.

* * *

A dynamo-electric machine which gives one ampere at 25,000 volts has been constructed for the purpose of testing the insulation of the transmission line between St. Maurice and Lausanne, Switzerland. The armature, which is stationary, has an internal diameter of 580 millimeters, and a length of 300 millimeters. It consists of 48 Gramme coils, each with 500 turns of silk-insulated wire, 0.5 millimeter in diameter, the total resistance being 700 ohms. The commutator consists of 96 air-insulated segments, and is connected by rotating brushes to stationary slip rings. The rotating magnet has two poles, and is constructed of laminated iron. It takes eight amperes at 80 volts, and revolves at 600 revolutions per minute. An air blast is brought into play on the brushes to prevent sparking.—*Western Electrician.*

* * *

The Otis Elevator Co. have been awarded the John Scott legacy medical and premium by the Franklin Institute for their electric elevators for use in private buildings. These elevators are operated by pushing buttons, in the car and on the different landings, and thus render the services of an operator unnecessary.

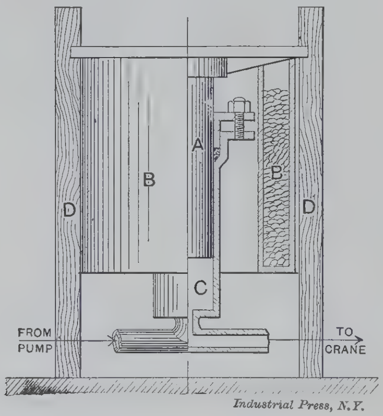
HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

17. H. E.—Please explain the construction and use of the hydraulic accumulator.

A.—The hydraulic accumulator, the simplest form of which is shown in half section in the cut, is used for storing up a large quantity of water under pressure to be used for operating cranes, elevators, punches and other hydraulic machinery. If a pump alone were depended on, it would have to be of sufficient capacity to supply the maximum demands for power, while with the accumulator a small pump may be used and the power stored up ready to be drawn upon as needed. The accumulator in no way increases the pressure but simply acts as a reservoir so as to make a large quantity of power always available.



Industrial Press, N.Y.

The inlet at the left is connected to a steam pump from which the water enters the bottom of the cylinder *C* and forces up the piston *A*. Connected with the top of this piston is an annular chamber *B*, which is filled with scrap iron, or other heavy material, thereby producing the required pressure on the water in the cylinder. As the piston reaches the top of its travel, it encounters a tripping lever which shuts off the steam and stops the pump. When the crane, elevator or other machine is started the piston begins to descend and in so doing the pump is again started. So long as the demand for power is equal to the supply from the pump the water would pass directly from the pump to the machine without entering the accumulator, but should the demand exceed the supply from the pump the accumulator would at once make up the deficit. In the sketch the tripping levers and connections have been omitted, for the sake of clearness, the posts *D D* are simply guides for controlling the motion of the weight-cylinder.

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18. C. A. K.—Will you kindly tell me how to calculate the number of revolutions or parts of a revolution that must be made by the feed screw of a shaper for cutting diametral pitch racks. Please show how to make the calculation for a screw having single, double or triple threads, and indicate how a collar should be graduated by which the feed screw can be turned the necessary number of divisions to advance the rack the required distance in spacing the teeth.

A.—The same principle is employed in calculating the spacing for rack cutting in the shaper that is used in cutting the threads of diametral pitch worms in the lathe. The latter subject was fully explained in the September, 1902, number of MACHINERY in the How and Why department, to which we refer you. To make the subject of rack cutting as simple as possible, let us suppose at first that we have a rack of one diametral pitch and that the feed screw of the shaper is of one inch lead, or, in other words, that it has one thread per inch. Having determined how to space such a rack with this feed screw, it will be a simple matter to calculate the spacing for a feed screw having a greater number of threads per inch and for a rack of finer pitch than one. The circular pitch or distance from tooth to tooth of a rack of one diametral pitch is 3.1416 inches. Consequently the shaper table must travel 3.1416 inches every time a tooth is to be spaced, to accomplish which the feed screw must make three turns and .1416 of a turn more. This decimal expression 3.1416 is equivalent to the common fraction 22-7, very nearly, and so if we use gears in the ratio of 22 to 7, or say one gear with 44 teeth and one with 14 teeth, for turning the screw, the purpose will be accomplished. Put the small gear or pinion on the end of the feed screw and the 44-tooth gear on a pin attached to the frame in such a position that the two gears will mesh. Then one complete turn of the large gear will cause the small gear, and hence the screw, to turn 3.1416 times (approximately, the error per rack tooth in this case being about 1¼ thousandths).

In applying this principle the first step is to find how many turns the gear must make to space a rack of one pitch on the shaper that is to be used. To do this, measure the distance traversed by the shaper saddle for one turn of the screw, and note what fractional part of an inch it is. It makes no difference whether the feed screw has a single, double or triple thread; all that is necessary is to measure the distance moved for one turn of the screw and calculate accordingly. Suppose it is found to advance one-third of an inch, or one-third as far as assumed above. Then it is evident that the gear would have to be given three turns, instead of one, to space a rack of one pitch.

Having found how many turns the gear must make to space a one-pitch rack, the next step is to find how many turns the gear must make to space the particular rack to be cut. Suppose a 6-pitch rack is to be cut, making it necessary to move the table only one-sixth the distance required for a one-pitch rack. The gear would then have to turn only one-sixth as far; or, in the case last assumed, 1-6 of 3 turns, making 3-6 or ½ turn. For another example, suppose the shaper saddle to move ½ inch per turn of screw and that a 10-pitch rack is required. Then,

Turns of gear required for one-pitch rack = 2 × 1 = 2.

Turns required for 10-pitch rack = 1-10 × 2 = 2-10 = 1-5.

The dial on the large gear should thus be graduated into fifths.

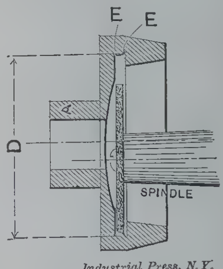
Instead of using the one-pitch rack as a basis for calculation, as has been done in the above explanation, it is more customary to take the 4-pitch rack as a basis, this being as coarse as is often cut on a shaper. In this case we could use a gear of 11 teeth on the pin in place of the 44-tooth gear, so that one turn of the gear would advance the rack only one-fourth as far as before. For example, suppose we are to cut a rack on a shaper, the saddle of which advances ½ inch per turn of screw. To cut a 4-pitch rack we should have to turn the gear 2 × 1 = 2 times. To cut an 8-pitch rack, 2 × 4-8 = 1 turn; a 6-pitch rack, 2 × 4-6 = 8-6 = 1 1-3; a 10-pitch rack, 2 × 4-10 = 8-10 = 4-5 turn, and so on.

If it were found that the table fed one-third inch per revolution of screw, then for 6-pitch rack, 3 × 4-6 = 12-6 = 2 turns; and for a 10-pitch rack, 3 × 4-10 = 12-10 = 1 1-5 turns.

Answer to No. 11.

In answer to inquiry No. 11, by Baer and Remple, in the February number of MACHINERY, we have received the following, from H. G. Stoner, Waynesboro, Pa.:

A.—Referring to the sketch, I would suggest that the race *D* be first turned as near to size as possible, leaving only enough stock to allow for truing after hardening. The corners of the race should be turned relieved as shown at *E, E*. Harden the piece in the usual manner.



Industrial Press, N.Y.

The universal grinder is best adapted for finishing, as almost any of these machines can be arranged to chuck the piece in the headstock and revolve with it while the internal grinding attachment carries the grinding wheel. For this particular job what is known as an elastic emery wheel is the best adapted. This should be slightly narrower than the width to which the race has been turned in order to allow it to go to the bottom. After the race is ground to the proper diameter the wheel is moved sidewise until the proper width is attained. Elastic emery wheels can be made very narrow and accurate by grinding the faces in the same manner as is employed for grinding the sides of metal slitting saws. With the above method a very accurate job can be produced and if but a small amount of stock is left for grinding, the pieces can be finished rapidly.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

NEW THREE-FOOT RADIAL DRILL.

The accompanying illustrations show a new 36-inch radial drill that has just been brought out by the Mueller Machine Tool Co., Cincinnati, Ohio. The column is made of one piece and is fastened to the base so that it does not revolve as is customary in most radials. On the inside of the column, four webs extend the full length and thus enable it to resist firmly all strains even when the arm and spindle are at their maximum positions. Just above the swinging platen, around the column, there is a graduated ring that revolves with the arm. This is a useful feature when duplicating parts which are held in fixed jigs clamped on the base or platen, as the spindle can be brought exactly to any former position by readings on the 0 line on the stationary column.

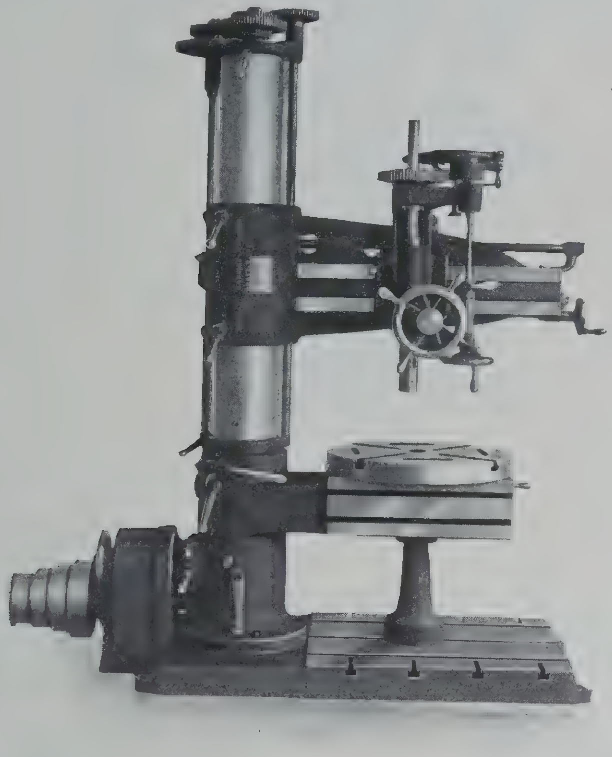


Fig. 1. Mueller Three-foot Radial Drill.

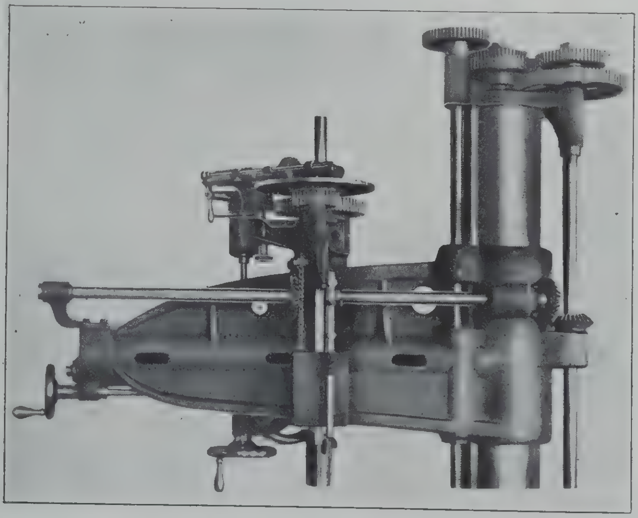


Fig. 2. Back View of Arm.

The arm is made in pipe section, its upper brace being as near as possible to the head while the lower one is at the outer edge. This arrangement will be seen by referring to Fig. 3, which is an end view of the head and arm. This disposition of the ribs of the arm prevents it from twisting when receiving the upward pressure of the spindle in drilling.

The arm is supported by a cap resting on roller bearings. Both make a complete circle about the column and can be instantly locked by fixed binder levers. The arm is lowered at nearly three times the elevating speed by means of a screw which is driven from the center shaft without the use of any intermediate gears. A bronze plate, attached to the side of the arm, shows the operator the correct speed for drilling either cast iron or steel.

The head is traversed by means of a screw that engages with a revolving dial on the outer end of the arm, enabling the operator to bring the head within .001 inch to a required position. Provision is also made for locking the head to the arm. The spindle is counterbalanced and has quick advance and return. When used for tapping, it is impossible to accidentally engage either automatic or lever feed and the danger of breaking taps is thus eliminated. A gage screw causes the spindle to stop when the tap reaches the bottom of a hole. Sixteen spindle speeds are available, ranging from 18 to 370 revolutions per minute, and the change from fastest to slowest occupies only about four seconds. The speeds are changed, and the lowering and elevating mechanism operated, by a single starting lever which extends from a loose ring encircling the column above the swinging column. This ring is adjusted to any position about the column and is connected, on the inside, to a rod which operates the two noiseless friction clutches on the shaft *N*, Fig. 4. When the spindle is not in use the lower driving shaft *Q* is the only one in motion. When the starting lever is pushed to the left, the friction clutch *P* causes gears *G* and *H* is to drive shaft *N* at low rate of speed. When lever is pushed to the right the same clutch causes gears *I*, *L*, *K* and *J* to drive shaft *N* at a higher speed. By allowing the gears *C* and *B* to mesh, two changes of speed are delivered to the spindle and by meshing gears *E* and *A* two faster speeds are given, thus obtaining four speeds from each of the four steps of the cone, or 16 changes in all. When a reverse motion of the spindle is required, the tumbler *O* is changed, causing gears *L*, *M* and *J* to run shaft *N* in the opposite direction and at an increased speed. The crank shown on the lower part of the column is used to lower the shaft *R*, inside of the column. In elevating or lowering the arm, this crank is pushed to the right, causing the shaft *R* to engage gears *D* and *F*, which drive the elevating screw.

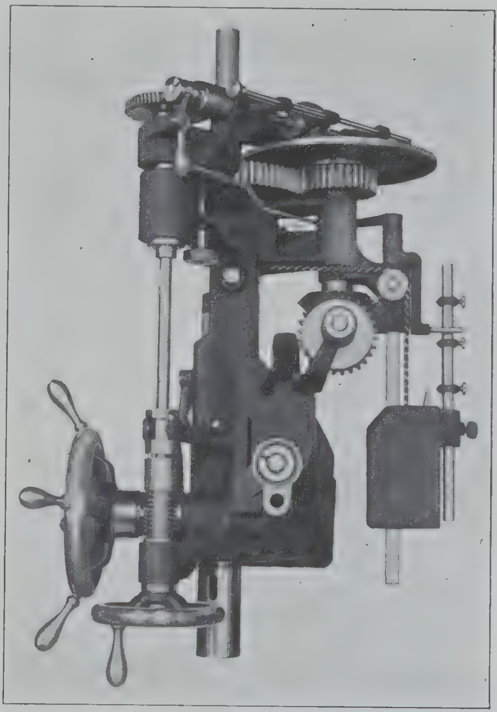
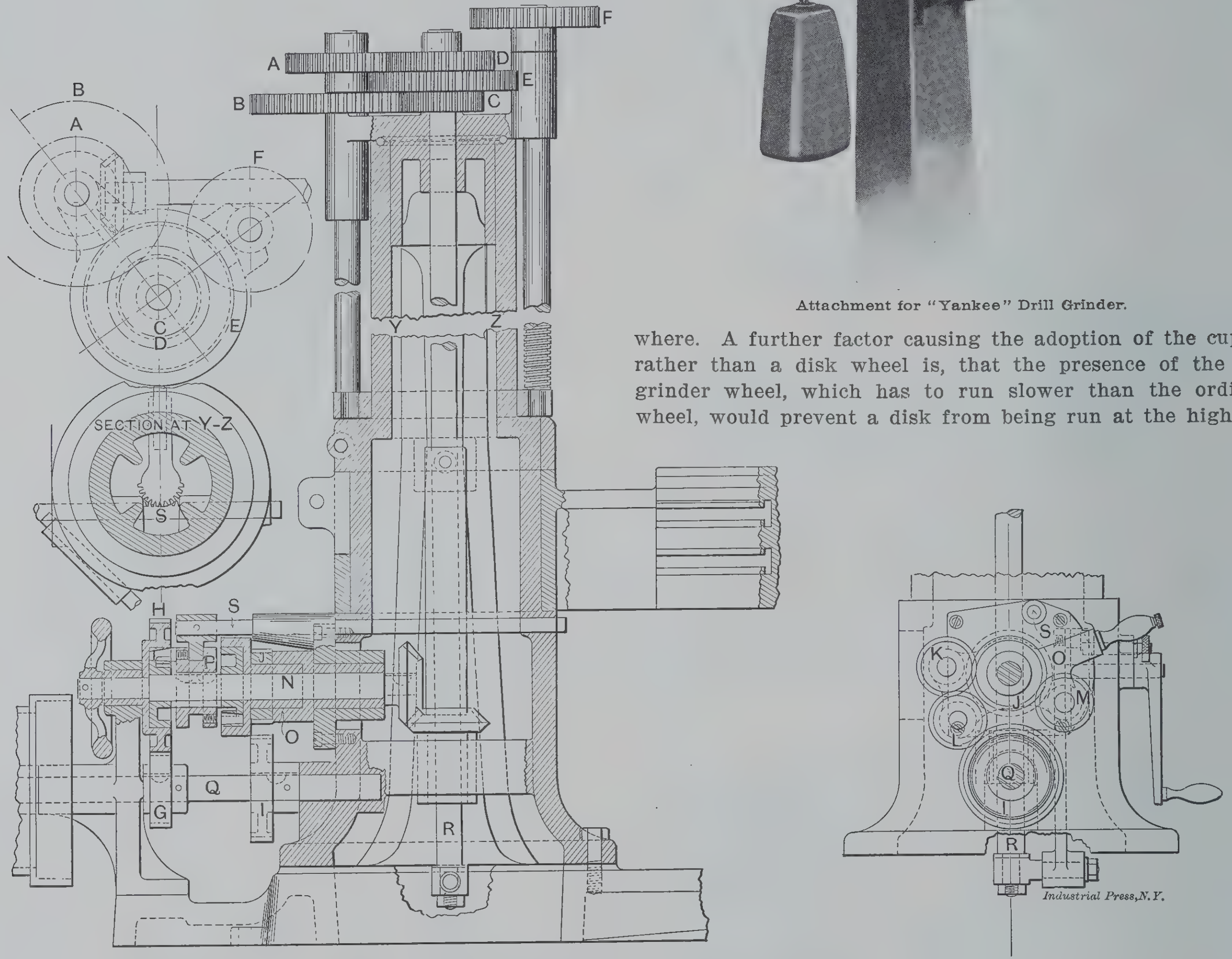


Fig. 3. End View of Arm and Head.

The automatic feed, the details of which are most clearly shown in Figs. 2 and 3, is driven through a friction plate fastened to the spindle pinion shaft. By moving the small friction wheel from the center to the outer edge of the friction plate, by means of a graduated rod, any feed from 0 to .23 inch per revolution of the spindle can be obtained. The amount of friction required for light or heavy drilling is regulated by a knob shown at the right of the feed shaft in Fig. 3. An automatic trip is provided which prevents feeding of the spindle after reaching the limit of its travel. A graduated bar, attached to the counter weight, carries several dogs to trip the spindle as often as desired. The automatic feed can also be tripped by the lever shown on the vertical feed rod.

The platen is usually plain but can be furnished with round or swivel table if desired. It has a round boss in the center that can be bored to receive bushings for boring bars which pass through the center of the supporting stand on the base. The net weight of this drill is about 3,800 pounds.



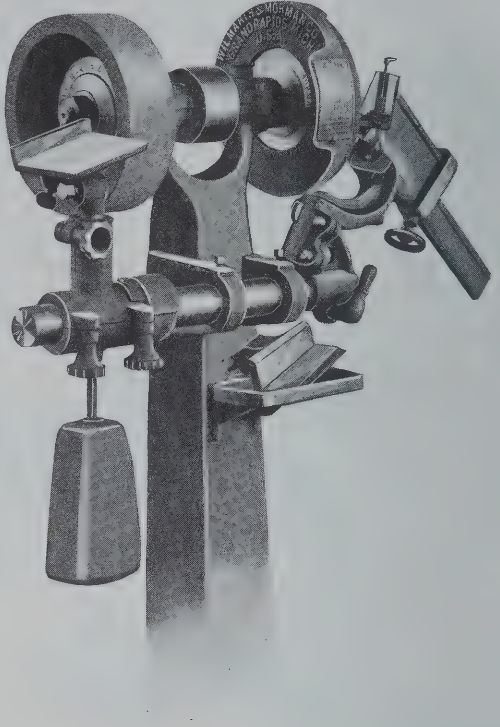
Industrial Press,N.Y.

Fig. 4. Detail of Driving Mechanism of Mueller Radial Drill.

GRINDING ATTACHMENT FOR TWIST DRILL GRINDERS.

The accompanying photograph illustrates a grinding attachment that the Wilmarth & Morman Co., Grand Rapids, Mich., have lately designed for use with their "Yankee" twist drill grinders. As will be seen, arrangement is similar to that used in the disk grinders and consists of a table, with its supports, which oscillates about a stud and is kept in a vertical position by means of a swinging counterbalance. Two tables are furnished; a flat one that has a ridge at the side against which to square the work, and a V-shaped table for holding round or odd-shaped pieces. These tables may be quickly interchanged, without the use of a wrench, and are adjustable for angles as well as up and down. Cutters, chasers, punches, dies and similar pieces that would otherwise be planed, milled or filed may be readily ground with this attachment. A collar, adjustable on the stud, limits the movement of the table toward the wheel and a shield keeps the adjusting mechanism free from grinder dust.

A cupped wheel is used and as the work is moved completely across its face there is no tendency for it to wear out of true so that it possesses the advantages of the emery-paper faced steel disk. When the wheel has been worn back to the web a plain wheel remains which may be used up elsewhere. A further factor causing the adoption of the cupped, rather than a disk wheel is, that the presence of the drill grinder wheel, which has to run slower than the ordinary wheel, would prevent a disk from being run at the high rate of speed at which it is the most efficient. For use in shops where the drill grinder is already installed the builders are prepared to furnish the grinding attachment on the column, as shown in the cut, but without the drill grinding feature, a plain wheel being substituted for the drill grinding wheel.



Attachment for "Yankee" Drill Grinder.

MULTIPLE INDEX CENTERS.

Multiple index centers are in common use for manufacturing and are very valuable for such purposes as fluting taps, reamers or similar work. The set of multiple centers shown in Figs. 1 and 2, P. 441, are capable of holding and indexing simultaneously four pieces ½ inch or less in diameter. The head spindles are geared together and are operated by turning the ball-handle on one spindle upon which is mounted the dial. The index-pointer is adjustable so that several indexes are carries on one dial. The tailstock is adjustable along the base-plate, and the plate has a countersunk bolt for securing to a milling machine slide. The tail-spindles have individual quick redrawal by lever and come forward by spring. They are all bound simultaneously by one handle.

The taps are held by the square end and supported at the tail-spindle end by female centers for small taps and male centers for the large ones. Both head and tail-spindles are fitted with No. 1 Morse taper centers, which can be quickly changed and make it possible to set up for large or small work on the same centers. The head-spindle center *A*, has a taper countersunk hole and across this are two saw cuts at right-angles. The square end of the tap is centered in the taper hole and the corners of the square catch in the saw cuts which dog it round. The tail centers, in practical use, are milled down close to the center line, to give access to the cutter.

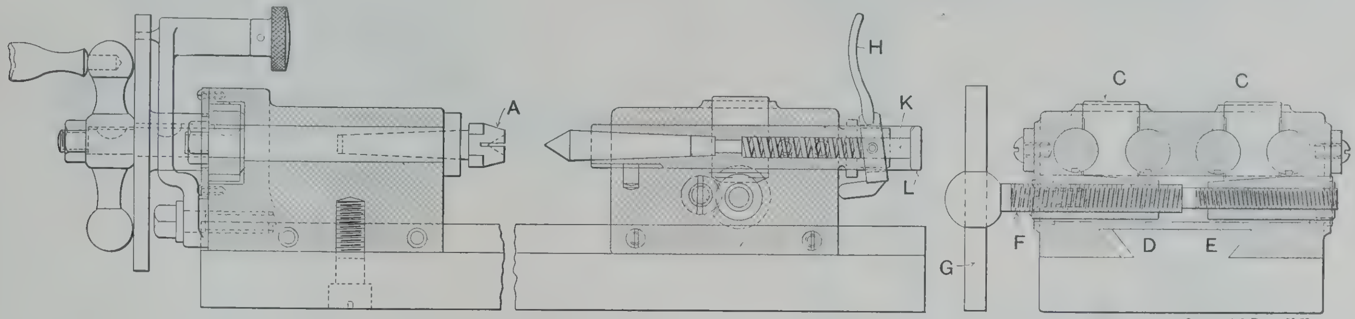


Fig. 2. Section through Multiple Index Centers.

The method of binding the tail-spindles simultaneously is shown in Fig. 2. Between each pair of spindles is a plug *C*, fitted with a slight looseness. The lower ends of these plugs are bevelled, and rest on two bushings, *D*, *E*, which are tapered on the upper side to match the incline of the plugs. The bushings are fitted with a right and left-hand screw, *F*. When the screw is turned by the handle *G*, the bushings are forced to approach each other and this forces up the plugs, which jam equally against both spindles. When the screw *F*, is turned in the other direction the spindles are positively loosened. The tail spindles are moved by the levers *H* and each is bored out and carries a spring plunger *K*, which abuts against the yoke *L*. The centers are manufactured by the Garvin Machine Co., New York, N. Y.

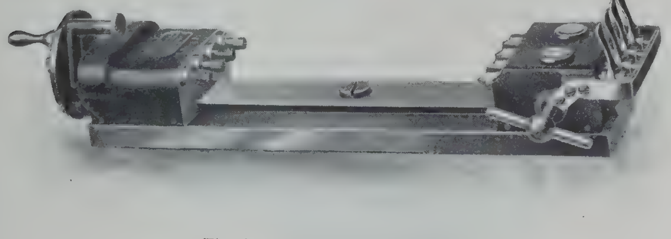


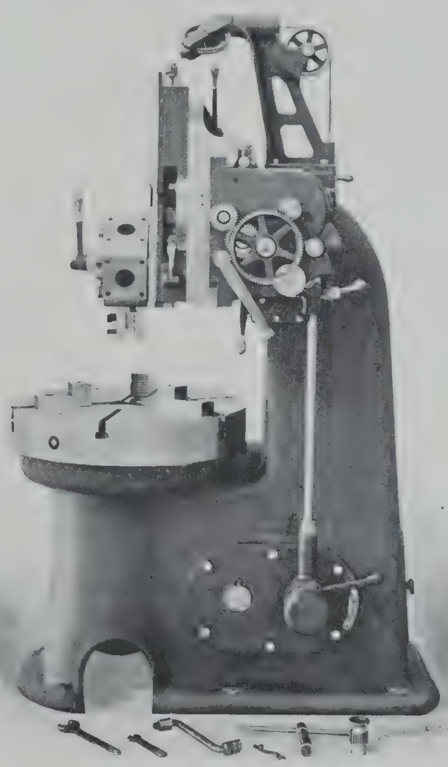
Fig. 1. Multiple Index Centers.

VERTICAL BORING AND TURNING MILL.

The half-tone herewith illustrates a new vertical boring and turning mill that is manufactured by the Colburn Machine Tool Co., Franklin, Pa. This mill swings work up to 34 inches in diameter and will swing 14 inches under the cross rail, while the extreme height from chuck to turret is 22 inches. The chuck has three jaws which may be operated universally or independently. The driving gear is fastened directly to the chuck so that no twisting strain is brought upon the spindle. The driving gears and back gearing are all contained in the frame of the column where they are protected from dirt and chips. A door at the back of the column makes it possible to inspect the gearing without dismantling the machine.

The turret slide has a travel of 18¾ inches, with automatic adjustable stops for tripping the feed. A counterbalance weight, suspended within the column and attached to the turret slide, facilitates raising and lowering the turret head. The turret is five-sided and bored for carrying five tools, while the sides have tapped holes, thereby providing a means for fastening special tools to the turret. An ingenious feature that has been incorporated in this machine is the arrangement for swinging the turret slide to any angle. To do this, the counterweight cable is clamped to the back of the column and then, when the head is fed out by the cross feed screw the cable pulls the top of the slide over until the proper angle is reached. This does away with the trouble of prying the head over with a bar, as is necessary in machines not so equipped, and renders possible a very quick and accurate setting of the turret slide.

The cross slide has a travel of 15½ inches, automatic adjustable stops for tripping the feed, and means for clamping the slide to the rail without the use of a wrench. Both vertical and horizontal feeds are positive, gear driven, and provided with automatic adjustable stops. There are eight changes of feed for each speed of the cone. These changes are effected by means of two levers, one giving four changes and the other increasing them four to one. The entire feed mechanism may be stopped, started or reversed by means of a hand lever at the base of the machine. The feeds may be stopped at five different points in the train; by using the feed trip lever, by withdrawing the pinion on feed screw or feed shaft, by dropping out the feed-change lever, or by placing the feed-increase lever or feed reverse lever in central position. The vertical feed has a range from ⅛ to 1-80 inch per revolution of chuck, and the horizontal from ¼ to 1-40 inch per revolution. An index plate, fastened to the machine in clear view of the operator, indicates the feed. A screw-cutting attachment may be quickly applied to the machine, the bank of gears provided being arranged to cut from 4 to 14 threads per inch. The net weight of this machine is about 5,500 pounds.

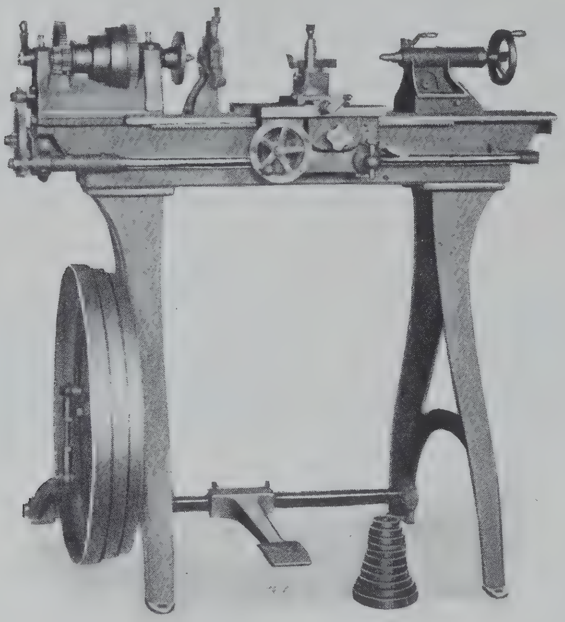


Colburn 34-inch Vertical Boring and Turning Mill.

NEW FOOT-POWER ENGINE LATHE.

The foot-power engine lathe illustrated in the accompanying half-tone has lately been brought out by the W. C. Young Co., Worcester, Mass. Although a foot-power machine this lathe is equipped with all of the appliances of a regular power-driven engine lathe.

It is back-geared, in the ratio of 8 to 1, and is supplied with a full set of screw-cutting gears, being capable of cutting from 6 to 72 threads per inch, or 6 mm. to .5 mm. when fitted with a metric lead screw. It has power cross feed and is furnished with plain or compound rest as may be desired. A taper attachment, of improved design, is constructed for use with this lathe.



Foot-power Engine Lathe.

The lathe is furnished with either 4- or 5-foot bed and will take, between centers, 24 and 36 inches for the respective lengths of bed. The swing over the bed is 10 inches and over the carriage, 6½ inches.

NEW SELF-OPENING DIE.

The illustrations, Figs. 1 and 2, present a new self-opening die that is being manufactured by the Maines Machine Co., Philadelphia, Pa. It is designed for use on lathes and screw machines as well as on other screw-cutting machines, in place of solid dies. It can be used for cutting either right or left-hand threads of standard or special pitch. A micrometer adjustment is provided at one side of the head, by which quick and accurate variations can be made in the diameters of the thread, for tight or loose fitting screws, as desired, and as the dies are adjusted simultaneously, the greatest accuracy is assured. The construction of the die and mode of holding are such as to allow a thread to be cut flush up to a shoulder if desired, and as the shank of the die head is made hollow, any length of thread may be cut which the travel of the lathe or turret slide will permit.

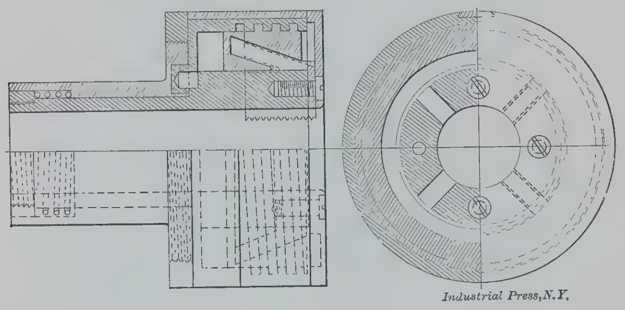


Fig. 1. Maines Self-opening Die.

The dies are opened automatically by simply stopping the travel of the carriage or turret slide, and in regular practice, the turret stop screw is set to govern the travel of the turret, and at the same time, the length of the thread to be cut, although the die may be opened at any point on the cut by simply holding back on the turnstile or lever by which the carriage or turret slide is moved, the dies being closed again by means of a small handle provided at one side of the head; or they may be closed automatically. The distinctive feature of this die head is the arrangement of the chasers which are so placed as to receive the thrust on top, thereby giving it the strength of a solid die.

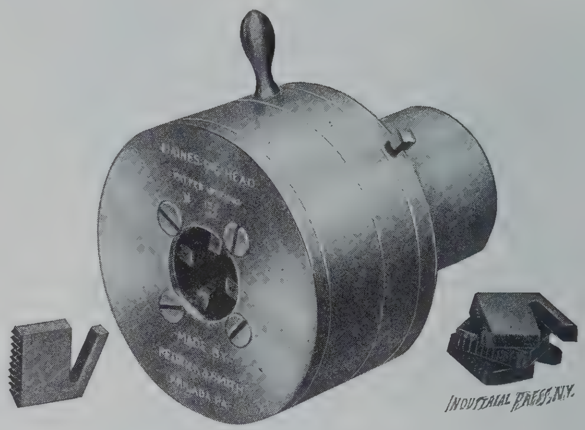
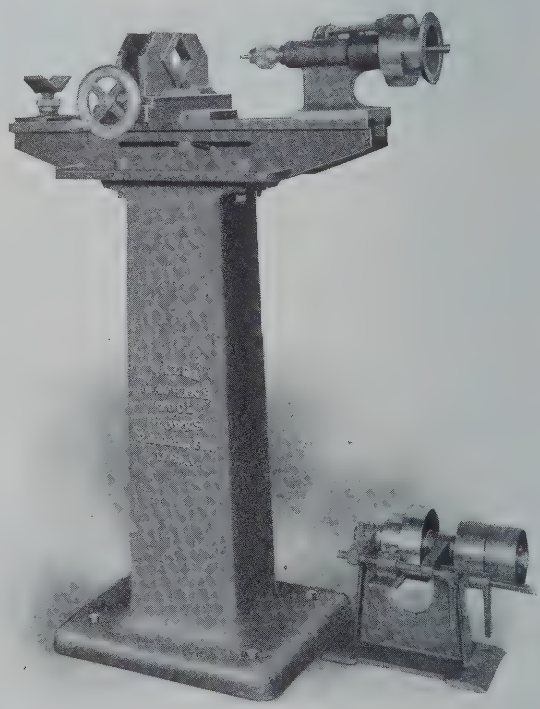


Fig. 2. Maines Self-opening Die.

CENTERING AND DRILLING MACHINE.

The Nazel Machine Tool Works, Philadelphia, Pa., have recently placed upon the market the centering and drilling machine illustrated herewith. This machine consists of an upright column or stand to which the bed is securely bolted. Upon this bed is mounted a drilling head and a two-jaw centering vise which can be clamped at any point along the length of the bed by a half turn of the binding nut. The bed has a bevel on the inside of the shears so that clamping the vise in this way insures accuracy and prevents any unnecessary strains on the shears. No matter how much wearing may take place, the center of the vise will always be in perfect horizontal alignment with the spindle. The form of the vise is such that not only round but square and octagonal-shaped pieces may be held equally well. The faces of the jaws are steel lined.

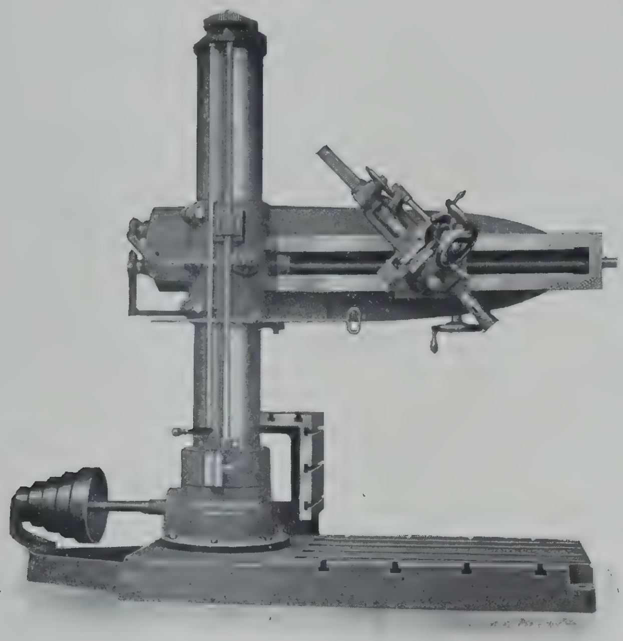


New Centering and Drilling Machine.

The spindle is provided with an adjustable stop collar for drilling any number of holes to the same depth. Combination center drills and countersinks are used so that but one operation, consisting of a simple movement of the hand lever, is necessary to perform both drilling and countersinking. The machine has a two-step cone and is furnished with short-work rest and drill chuck. An extension floor rest, for long work, can be supplied if desired.

NEW FIVE-FOOT RADIAL DRILL.

The Dreses Machine Tool Co., Cincinnati, Ohio, have just brought out the 5-foot radial drill that is illustrated in the accompanying half-tone. This machine is driven from a cone shaft, a central shaft in the column, spur gears on top and another pair of miter gears connecting the outside shaft with the back gears and the horizontal shafts. The inside column or stump extends nearly to the top of the column. The bottom is as large in diameter as is consistent with the strength of the outside column and is of small diameter on top so as to decrease friction and insure easy horizontal movement of the arm. The outside column rests on taper roller bearings which are alternately full size and slightly smaller in order to obviate friction between them. The inner and outer columns, near the base, are turned of the same diameter and the clamping band encircles both so that by means of the one screw, shown in front, horizontal movement is firmly arrested without injuring the anti-friction bearing.



Five-foot Radial Drill.

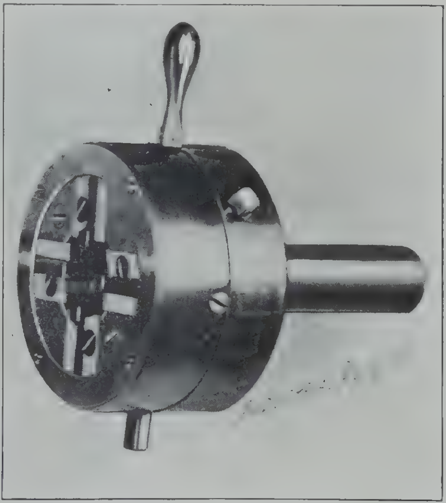


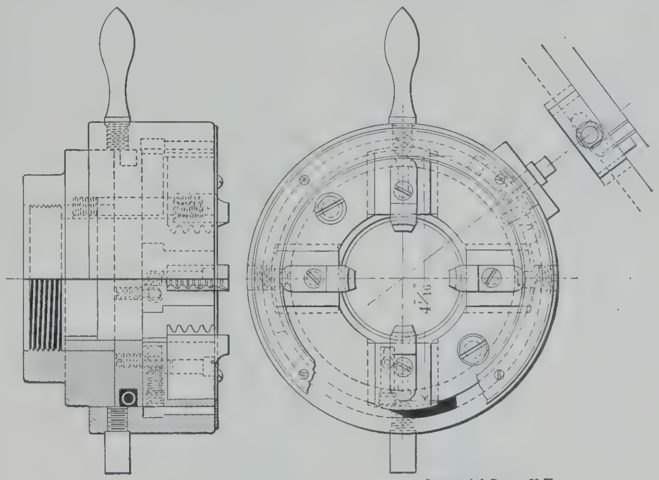
Fig. 1. Self-opening Threading Die.

The adjustable handle rod, shown below the arm, operates a double friction and starts, stops, engages the back gears, and reverses the spindle in the ratio of the back gears, all while the machine is in operation. The handle shown in front of the sleeve encircling the column, operates another double friction clutch by means of which the machine is set for reversing when tapping; and it can also be used for direct tapping, especially for small holes where it is desirable to run the tap forward at a high speed and back out at but slightly increased velocity. The spindle has positive geared feed which can be varied while drilling, by the handle shown in the slot. It has also a quick return which is operated by the large hand-wheel and it can be instantly engaged or disengaged by the handle above.

These machines are also made full universal, motor and variable speed countershaft driven. The latter can also be applied to the central shaft so that the arm can make a complete revolution without obstruction.

SELF-OPENING THREADING DIE.

The Modern Tool Co., Erie, Pa., have for some time been manufacturing the self-opening threading die shown in Figs. 1 and 2, but to most readers its design and construction will be new. Its features of excellence are its simplicity, strength, ease of changing the chasers, and permanency of setting. The chasers are mounted in four grooved blocks having radial movement and which move with the chasers when the die is opened and closed. The chasers are held in the chaser blocks by screws, but bear at their outer ends against the solid metal of the blocks, so there is no side stress on the screws. The blocks are in turn supported by the cam ring which takes the thrust, due to the cut, directly in line, thus avoiding all tendency to cant over and make the chasers cut tapering threads when the die becomes worn. The chasers being mounted in the grooved blocks, all wear due to the movement of the cam ring is taken by the blocks, so that there is no wear on the outer ends of the chasers.



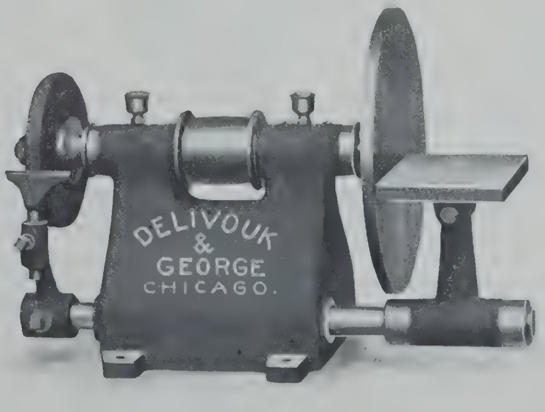
Industrial Press, N.Y.

Fig. 2. Detail of Self-opening Threading Die.

Threads may be cut flush to a shoulder and any length of thread may be cut since the shank is made hollow. The die is adapted to use on turret lathes and screw machines, being opened automatically when the limit of motion of the turret is reached. It may be closed by hand or automatically by a pin set opposite the handle which engages with the turret slide as the turret revolves. Adjustment is provided for varying the size of the thread for tight and loose fits.

BENCH DISK GRINDER.

The use of the disk grinder, employing a steel disk covered with emery cloth or paper, is increasing from day to day, and



Bench Disk Grinder.

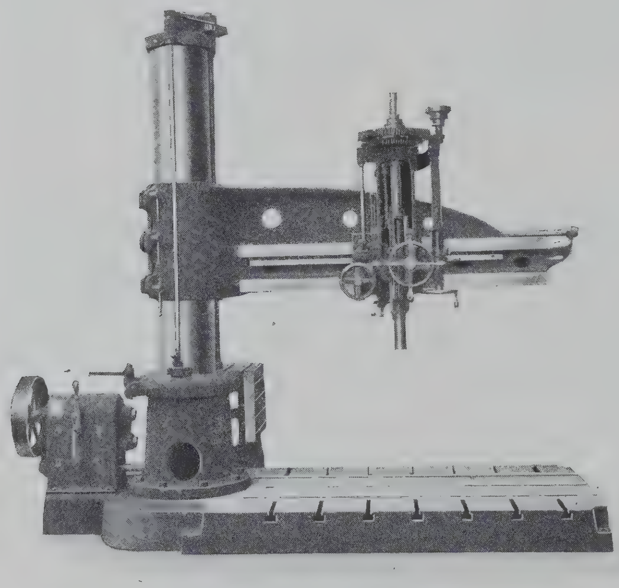
most of the builders of grinding machines are now combining the regular emery wheel grinder with the disk machine. The bench grinder, presented in the half-tone on page 443, carries on one end of the spindle a steel disk and on the other the regular emery wheel. The emery wheel is used for ordinary grinding and for roughing off the work before it is applied to the disk. The disk is adapted to grinding drop forgings and castings of all kinds and for finishing brass, copper, machine steel, aluminum and such work as gibs, nuts, wrenches and the various parts used in electrical construction.

The table has a rocking motion, which distributes the grinding to the full surface of the disk, or it can be clamped rigidly in position. It can also be set at any angle from 45 to 90 degrees. The emery paper or cloth can be secured to both sides of the disk by a quick drying cement, clamped in a press furnished for the purpose. A cup wheel can be used, in place of the disk, when desired, thus allowing the machine to cover a large range of work. This grinder is built by Delivouk & George, Chicago, Ill.

A NEW SPEED CHANGING MECHANISM APPLIED TO THE "AMERICAN" RADIAL DRILL.

The illustration shows the latest form of radial drill that has just been placed on the market by the American Tool Works Co., Cincinnati, Ohio. The drill itself embodies all of the features of the "American" radials, to which has been added the improved form of speed changing mechanism which takes the place of the ordinary cone pulley.

The device in brief is as follows: Two sets of friction clutches are controlled by the two levers shown on the front of the speed box. These two levers act independently and make it impossible to throw in any conflicting clutches, and so render a non-interfering device unnecessary. The friction clutches are of their double band type which have double the transmitting power of any other friction and when properly adjusted, form a practically solid connection. They are engaged or disengaged with very little effort through the medium of the levers as shown. The upper lever, thrown either toward *A* or *B*, communicates two rates of speed from the top shaft, through intermediate gearing to the lower shaft, the clutches on this shaft running at different speeds by reason of the different ratio of their gears. Then by throwing the lower lever toward *C* or *D*, each of the two speeds communicated by upper lever can be made to give two additional speeds to the lower shaft which carries the power to the machine. This, with double friction countershaft and back gears on the head, gives sixteen changes of speed to the spindle, arranged in geometrical progression, giving a wide range for drilling, tapping and boring. The makers are prepared to equip any of their drills with the above method of mechanism.



American Tool Works Company's Radial Drill with new Speed Changing Mechanism.

TIDAL ENERGY CONVERTED TO POWER.

Proceedings Canadian Society of Civil Engineers.

In a paper read before the last meeting of the Canadian Society of Civil Engineers, C. P. Baillairge discusses the power of the tides and shows why it has never been used to any extent and why, in his opinion, it is not likely to be. He considers briefly tide mills, in which the water from the rising tide is allowed to flow up a stream or tributary to the sea, where it is retained by a dam, having openings that are closed just as the tide turns to go out; and concludes that at best they are an expensive mode of getting power. He then takes up the two methods of actuating a rotating mechanism by means of the tides and of storing energy by using weighted floats which rise as the water rises and which in descending give out their potential energy to some form of mechanism.

The average direct motion or velocity obtainable at Quebec and vicinity may be taken at twelve feet rise and twelve feet fall or twenty-four feet per tide, or say, per twelve hours; though, due to the retardation of the moon's motion, the tides may be some fifty minutes later on each successive day. This is equivalent to a motion of two feet per hour; or taking it another way, the rising and falling tide can only cause one revolution of a wheel in twelve hours, if actuated by crank action.

Some motion or rotation of a wheel can be conceived of as actuated from a floating body rising and falling with the tide and operating a vertical rack which meshes in a pinion on the shaft of the driving mechanism. By this means several revolutions of the shaft might be obtained per diem.

But the net duty derivable from such machinery, due to loss by friction, is but about 85 per cent. of the initial power and the mechanism in this case, to arrive at any reasonable velocity for manufacturing purposes, must at least be quintupled; and if this same allowance for retardation by friction obtained throughout, the loss would not be less than five times 15, or 75 per cent., leaving but one-quarter of the initial power to the good.

If, however, the loss by friction, as may sometimes be warranted, be taken at only 10 per cent. instead of 15, there would still be but four horse power realized out of every ten of the direct lifting or falling power of the tide, and this alone is enough almost to dissuade any one from falling back upon or appealing to the tides for a lucrative mode of creating or utilizing power; and if we attempted to reach such higher velocities of revolution as required for electric power purposes, it is easy to see how the whole or nearly the whole of the initial power of the tides might be absorbed in so doing and not enough of it remain to make it a paying business.

Therefore, is it probable that if the tides have not as yet been utilized by man, it is because he has by mental process gone through the line of reasoning here laid down, and thus become convinced of the futility of making the trial, especially under the discouraging consideration that not only is there the loss by absorption by rubbing surfaces, but the other allowance of 10 per cent. for wear and tear, and consequent repairs, etc.

But as yet we have said nothing of what this power of the tides really is; this apparently, or at first sight, is almost irresistible power, since with the tide rises every thing upon its surface, even to a twenty or thirty thousand ton vessel of war, and which would similarly lift a city if built upon the water on a water-tight platform with depth of water sufficient to allow it to sink till the weight of water displaced were equal, as with a vessel, to the weight supported.

This great power, however, is only apparent as the tide wave has no greater power than that which is required to raise its own weight of water to the average height of one-half a tide or one-half the weight of water to the full height of amplitude; the weight of the vessel or other object on the water being supported by the water, irrespective of the lifting power of the tide, as represented by the hydrostatic pressure exerted as above mentioned, by the weight of the equivalent volume of water displaced; so that where the vessel or object rests or floats, the weight to be raised by the tide is the same as elsewhere or as where there is nothing on its surface.

In other words, the lifting force of the tide per square foot

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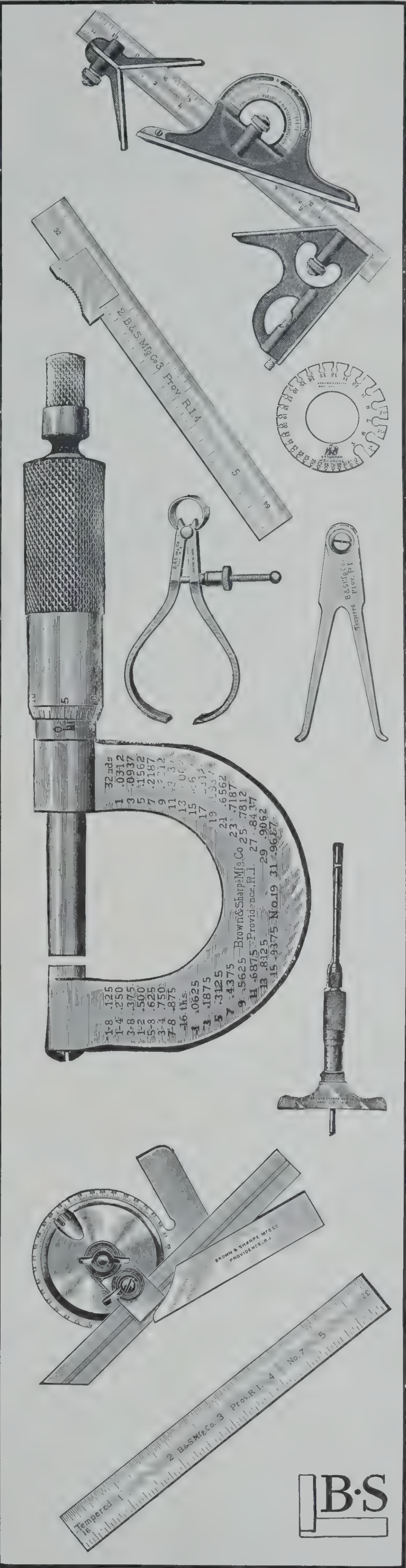
No. 103 Catalogue shows the complete line. It is furnished by Dealers, or we shall be pleased to mail it to any address.



is, for an average rise and fall of twelve feet, equal to twelve cubic feet of water or 750 pounds raised to an average height of six feet, making 4,500 foot pounds. But we also have the same power developed in the falling tide as in the rising tide and the 4,500 foot pounds must thus be doubled to represent same power developed in the falling tide as in the rising tide in twenty-four hours we thus get at the fact that every square foot water surface exercises 18,000 foot pounds in twenty-four hours.

A horse power is equivalent to 33,000 pounds raised to the height of a foot in one minute and thus every square foot of water surface in such a tidal river as the St. Lawrence is a source of power only equivalent to about one-half or two-thirds of a horse power in twenty-four hours.

Calling it equivalent to one-half horse power in twenty-four hours and remembering that the value of a horse power is 33,000 foot pounds per minute and that there are 1,440 minutes in one day of twenty-four hours, it is evident that double 1,440 or 2,880 square feet of float area would be necessary to secure one horse power continuously during twenty-four hours. We therefore arrive at the conclusion that, when running, as would be usual, during eight or ten hours out of the twenty-four, it would require an area of from eight hundred to one thousand feet or thereabout, of water surface, to represent one horse power or a float of say forty or fifty feet by twenty feet, or for one hundred horse power say again one of eight hundred to one thousand feet by one hundred.

And, therefore, if the writer's figures be correct, it is not to be wondered at that the power of the tides has never as yet been, nor is ever likely to be, economically utilized for industrial purposes.

* * *

NEW TRADE LITERATURE.

The Northern Electrical Mfg. Co., Madison, Wis. Booklet No. 31 describing and illustrating the Northern direct-current generators which are built in all standard sizes and in belted and engine types. The booklet is sent free on request.

The Betts Machine Co., Wilmington, Del. Catalogue No. 14 of improved slotting machines. They are built in the following sizes: 8-, 10-, 12-, 15-, 18-, 21-, and 24-inch and can be arranged to be electrically driven, if desired.

A. J. Polk & Son., Millersburg, Pa. Catalogue and price list of screw plates, taps, dies, reamers, milling cutters, etc. These are all described and illustrated, and the company call attention particularly to their common sense screw plate of which they are the inventors.

Baker Bros., Toledo, O. Catalogue No. 3B of drilling, boring and tapping machinery. Here are shown five styles of drill presses, various sizes of tapping and boring machines for large and small work, several sizes of chucks for holding flanges, a locomotive rod boring machine, built in two sizes, etc. The company state they will be pleased to send this catalogue to anyone interested.

The Whitcomb Mfg. Co., Worcester, Mass. Standard size catalogue of the Whitcomb planers. Eight sizes of these are shown, from the 17-inch to the 48-inch, and the 36, 42 and 48-inch planers are furnished with or without second belt drive, as desired. Several pages are devoted to a full description of the Whitcomb planers. The catalogue is printed on heavy coated paper, the illustrations are handsome, and it presents in general a most attractive appearance.

The Challenge Machine Tool Co., Inc., Philadelphia. Circular illustrating the "Challenge" emery wheel dresser, accompanied by small section of emery wheel showing the grooved surface that can be produced on the periphery of the wheel with this dresser. It is claimed that a wheel grooved in this manner is 25 per cent. more efficient than the ordinary smooth-faced wheel. The circular also describes the line of combination grinders manufactured by the company.

E. G. Smith, Columbia, Pa. New edition of booklet of Columbia calipers. A number of vernier calipers of various sizes and styles are shown and described. Spherometers, micrometers and the "Which Way" pocket level are also illustrated. Some testimonials of the satisfaction expressed by users of these various products appear, and a page is devoted to the Tripoli germ-proof filter, No. 4, also manufactured by Mr. Smith. This booklet will be cheerfully sent to anyone interested.

The Binsse Machine Co., Newark, N. J. Catalogue No. 2, 1903, of the "Binsse" horizontal boring machine. These tools are manufactured in three sizes: The B machine with 2½-inch, the C with 3¼-inch and the D with 4-inch bar. Sizes No. 3, 5 and 9 and their different parts are illustrated. Then follow examples of work that can be done on this machine, such as boring drill jigs and off-set brackets, drilling worm boxes and right and left worm shaft bearings, etc.

Pratt & Whitney Co., Hartford, Conn. Leaflet bearing a picture of the fine new building erected by the company for the manufacture of taps, dies, milling cutters, reamers, etc. The leaflet asks the pertinent question: "Can a small toolroom compete with a big factory?" the inference being, of course, that it cannot. A toolroom is a necessity for every well-ordered machine shop for the purpose of keeping tools in repair, but as a manufacturing proposition it is "not in it." The new building practically doubles the small tool department capacity of the company, which was already large.

The Brown & Sharpe Mfg. Co., Providence, R. I. Catalogue, 1903 edition, of the company's machines and tools. It contains 458 pages, has been thoroughly revised and considerable matter has been added. Its size, 5¾ x 3¾ makes it a volume convenient to handle, and the numerous tables and other useful information it contains render it valuable as a work of reference. It would not be possible to enumerate all the products described and illustrated in this catalogue, which those interested may secure, without charge, upon application. A very complete index is published at the beginning of this work, and a colored insert contains the principal additions of the past year to the various lines of machines and tools previously manufactured.

Hammacher, Schlemmer & Co., New York. Catalogue 180, of tools for machinists, metal-workers, carpenters, cabinet-makers, woodworkers, wood-carvers, patternmakers, jewelers, plumbers, gas-fitters, upholsterers, sculptors, masons, modelers, painters, paper-hangers, etc. This catalogue which is a large book of over 800 pages, handsomely bound in red cloth, embraces the large line of tools and mechanical supplies handled by this company, who have been in business in New York since 1846. The index alone covers 19 pages which gives an idea of the number of subjects catalogued. The book is profusely illustrated with cuts and is sent free to all manufacturing concerns. Private buyers can obtain copies by sending 60 cents which will be refunded when purchases to the amount of ten dollars have been made.

The Warner & Swasey Co., Cleveland, O. General catalogue 1903 of machine tools. This is a very handsome catalogue, printed on heavy coated paper and containing a large number of excellent half-tone engravings. Herein are illustrated the hollow hexagon turret lathe; the 30-inch vertical turret machine; turret screw machines Nos. 1 to 6; turret lathes with or without automatic chuck, geared-friction head or automatic feed; forming turret lathes of 12-, to 18-inch swing; three sizes of universal turret lathes; a two-spindle and a four-spindle valve milling machine; an automatic boring and tapping machine, made only to order; double head key lathes; a manufacturing milling machine, a cutting off machine; a horizontal boring machine, etc. Matter descriptive of these various machines, of their parts, and of their operation is given. In their introduction the company invite all interested, to visit their works at Cleveland.

MANUFACTURERS' NOTES.

J. D. Hurley and A. B. Holmes, formerly connected with the Standard Pneumatic Tool Co., are now associated with the Rand Drill Co., New York, in the "Imperial" pneumatic tool department.

The Railway Appliances Co., Old Colony Bldg., Chicago, Ill. have appointed Mr. C. C. Murray to represent them at Pittsburg, where he will devote his time principally to the sale of the Q & C. pneumatic tools.

R. McCarty, formerly manager of the Bignall & Keeler Mfg. Co., Edwardsville, Ill., has resigned his position with that company and on April 1st assumes the duties of manager of the Stoever Foundry & Mfg. Co., Myerstown, Pa.

The R. D. Nuttall Co., Pittsburg, Pa., recently received an order from a prominent automobile company for 12,000 gears. They state that they think this is the largest individual order for gears ever placed.

The Cleveland Pneumatic Tool Co., Cleveland, O., are now located in their new plant, corner 2d and Hawthorne Sts., where they have greatly-increased facilities. Their new plant is up-to-date in every respect.

The Espen-Lucas Machine Works, Philadelphia, Pa., builders of machine tools, and special machinery, have bought the designs, machines, jigs, tools, etc., of the Franklin Machine Works, Inc., Philadelphia, and are prepared to supply these machines and other machine tools at short notice.

The O. K. Tool Holder Co., Shelton, Conn., have just added to their line a new holder which is ¾ inch x 1⅜ inches, known as size D, and also another size to their cutting-off tools, ⅝ inch x 1¼ inches, known as size C. The business of this company is increasing very rapidly, showing that their tools are meeting with the approval of users.

The Northern Mfg. Co., 253 East Eighth St., St. Paul, Minn., have been incorporated with a capital of $50,000, to do a general manufacturing business. Their specialties are Northern metallic packing, the Curran locomotive whistle and the Furhman-Nelson pneumatic motor, etc. The officers are: Alfred Munch, president; S. B. Mack, vice-president; S. R. Parslow, treasurer, and D. E. Anderson, secretary.

The American Tool Works Co., Cincinnati, O., have recently undergone some changes in the personnel of their management. Franklin Alter is president; Henry Luers, secretary and treasurer; J. B. Doan, general manager; A. E. Robinson, general superintendent. The company report that February's business was the largest month's business in their history. Extensive alterations are being made to meet their increasing needs. They have just brought out several new tools, and state they are much gratified at the success attending their introduction.

The Northern Engineering Works, Detroit, Mich., crane builders, report a large volume of business and an increasing demand for their electric traveling cranes. Among the orders recently received are the following: C. D. Jackson & Co., a 25-ton crane; the Detroit Shipbuilding Co., five cranes, of from 5 to 40 tons; the Allis-Chalmers Co., 12 cranes; the American Shipbuilding Co., 3 electric cranes. Also orders from P. A. Clum & Co., the C. & G. Cooper Co., and the Macbeth Iron Co. They are also installing their hand power cranes of the traveling and jib type.

The Philadelphia Pneumatic Tool Co., Philadelphia, Pa., have secured a contract from the Lake Shore & Michigan Southern Railway Co. to supply them with all the pneumatic hammers which they will use in the new Collinwood Shops and on the entire system for a period of one year. This contract is awarded after a competitive test of all the different makes of pneumatic tools. They have also received large orders for chipping and riveting hammers and drills from the Wabash, the Delaware & Hudson and the Central of New Jersey Railroads.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line.

The money should be sent with the order.

AN INVENTOR of a new system of locomotives with extraordinary power upon 2 and 4 buggies, all wheels being drivers, desires the association of a capitalist for obtaining patents from different countries. and building of such engines. Address ANTHONY TITTEL, 2306 So. 11th St., St. Louis, Mo.

BOOK, "DIES AND DIEMAKING," 100 6x9 pages, $1, post paid; send for index. J. L. LUCAS, Bridgeport, Conn.

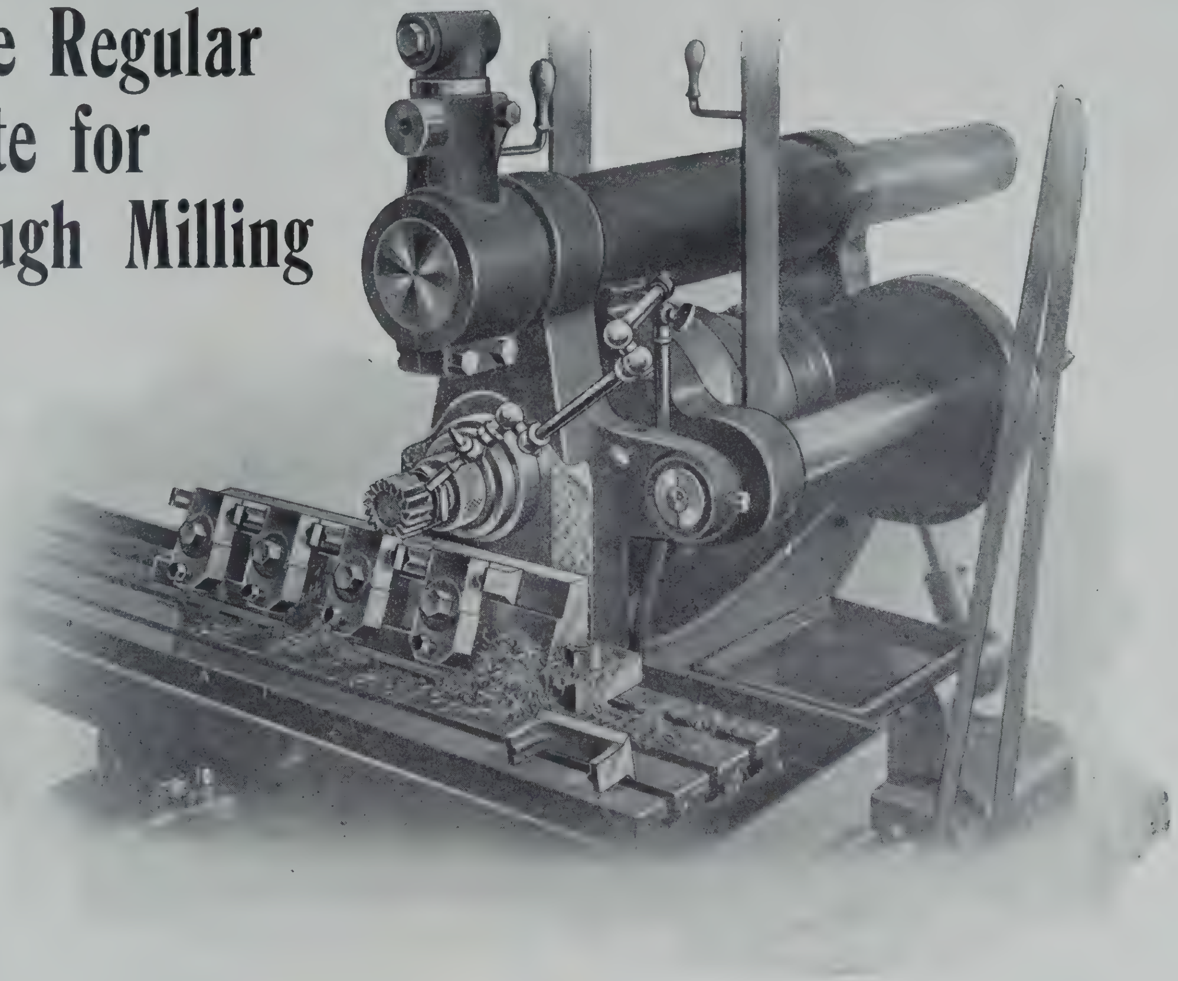
EXPORTERS to Germany desiring catalogs translated will find it profitable to address E. O. Reuleaux, Mech. Eng., Wilson, Pa.

EXPERIENCED advertiser, correspondent, and machine salesman, several years connected with leading manufacturing house, is open for engagement. A1 references. Address W. T., care Machinery, 66 West Broadway, N. Y.

FOREMAN.—First class mechanic desires position as foreman on any mechanical work. Position must be permanent. Address Foreman, care Machinery, 66 West Broadway, New York.

(Continued on page 448).

The Regular Rate for Rough Milling



these pieces of drop-forged steel is at a table feed of 6 inches per minute on the

NO. 2 PLAIN CINCINNATI GEARED-FEED MILLER.

The cutter makes 120 r.p.m., feeding .050 inch per turn, taking a cut 5-8 inch wide and removes 1-16 inch of stock; then the feed is reduced to .033 inch—4 inches table travel per minute for the finishing cut.

This change in feed is accomplished by the simple movement of the lever without stopping the machine. This is our quick feed-change feature, which is just as important as the geared feed.

How long does it take to change the feed on the millers you are using? If they are not new "Cincinnatis", you are losing a lot of time.

ASK FOR "EXAMPLES OF RAPID MILLING."

We are Milling Specialists.

The Cincinnati Milling Machine Co.

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg, Brussels and Stockholm. Adolphe Janssens, Paris.
Chas. Churchill & Co., London. Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
Niles-Bement-Pond Co., 39 Victoria St., London, S. W.

MISCELLANEOUS (Continued from page 446).

FOR SALE—1 Reihle Brake Testing Machine for Gas Engine Work; cost $300.00 new. THE PATTERSON TOOL & SUPPLY CO., Dayton, Ohio.

FOR SALE CHEAP.—An office telephone system with five stations, in good order. Address, "TELEPHONE," care of MACHINERY, 66 West Broadway, New York.

FOR SALE CHEAP.—New treatise on welding and forging all the new steels, and five welding compounds for same. Thermit welding is also explained, and 75 new steel working methods and receipts covering all difficult smithing. Two colored scientific tool tempering charts A and B, also all the above for one dollar. Samples free. W. M. TOY, Sidney, Ohio.

MACHINERY SALESMAN WANTED, to handle as a side line, machines suitable for use in all wood and metal working factories. Address "SALES," care MACHINERY, 66 West Broadway, New York.,

MACHINISTS' 50 PAGE BOOK.—Rules and Pointers just from press. Price 25 cents. Address WM. POWLES, 485 North St., St. Paul, Minn.

MACHINISTS send 5 cents in stamps for blue print table of U. S. standard steam, gas and water pipe, giving tapping sizes. Address E. E. MEYER, Allegheny, Pa.

MACHINISTS.—The Monotype Company has openings for intelligent young machinists. For a limited period free instruction will be given to a few, and expenses paid while learning, to fill waiting positions at good wages. Write for application blank to THE LANSTON MONOTYPE MCH. COMPANY, 1231 Callowhill St., Philadelphia, Pa.

PATENT YOUR ORIGINAL IDEAS.—They may be valuable some day. If in doubt as to patentability, write me, giving sketch and full description, and I will give you my opinion as to patentability free of charge. F. H. KING, Patent Lawyer and Solicitor, 1462 Monadnock Bldg., Chicago, Ill.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

SEE my Test Indicator, page 31. H. A. LOWE, Waltham, Mass.

THE Wellman Sole Cutting Machine Co., of Medford, Mass., designs and builds light machinery. Correspondence solicited.

WANTED.—Heavy boring mill and lathe work; also machinery to build on order. KROM MACHINE WORKS, 10 Essex St., Jersey City, N. J.

WANTED.—All kinds experienced engineers, draftsmen, foremen and superintendents to register; positions open. CLEVELAND ENGINEERING AGENCY, Box 71, Station B, Cleveland, O.

WANTED.—Second-hand electric traveling crane, about 30 ft. span, stone capacity. Address POORMAN MFG. CO., Piqua, O.

WANTED—By a practical machinist and marine engineer, position as foreman, master mechanic or superintendent of construction. Contracted and built Rolling Mills, Distillery, Cooperage and Glucose Machinery; also built, tested and set up Marine Engines in steamers. Best of reference. Chicago reference, Robert Tirant, Engine & Tool Builder. Address "J. C. F.," care MACHINERY, 66 West Broadway, New York.

WANTED.—A responsible firm to manufacture on royalty a specialty in machine tools which has been on the market and in successful operation for several years. The present owner lacks the facilities and capital to produce them in sufficiently large quantities. Address "MACHINE TOOL," care of MACHINERY, 66 West Broadway, New York.

WE HAVE COMPLETED a modern, up-to-date foundry and machine shop, equipped the same with the latest and most improved machinery that could be purchased, and are wanting journeymen patternmakers, moulders, and machinists, and invite applications for these positions. Apply or address KENNEY & CO., Scottdale, Pa.

WANTED.—A first-class machine tool salesman to travel in the South for a Southern House. State experience, age, present employment and salary expected. SOUTH, care of MACHINERY, 66 West Broadway, New York.

WANTED.—A first-class foreman to take general charge of a small shop manufacturing power transmitting machinery. Must be a hustler and understand this line of business. State experience, shops employed in, and salary expected. TRANSMISSION, care of MACHINERY, 66 West Broadway, New York.

WANTED.—A machinist in every shop to sell my Calipers and Levels. Liberal proposition. Address E. G. Smith, Columbia, Pa.

WANTED.—First-class floor hands experienced in the erection of Machine Tools, those familiar with lathes or shapers preferred. Steady employment at fair wages. State where now employed and give record of employment for past five years. A good place, fair treatment and congenial surroundings. Town of 30,000, living expenses reasonable. Address, giving full particulars as to age, etc., W., care of MACHINERY, 66 West Broadway, New York.

WANTED.—An American born and educated mechanical engineer to travel, introducing our line of Pneumatic Machinery and Labor Saving Devices for shops, foundries, and other classes of manufacturing plants. Must have some manufacturing experience and ingenuity to apply our devices successfully. CURTIS & CO. MFG. CO., St. Louis, Mo.

WANTED—A few more orders for Gray Iron Castings. Have increased our foundry capacity and would like an opportunity to figure on your work. ATHOL MCHE. CO., Athol, Mass.

WE are constantly increasing the scope of our work, and invite applications for positions from first-class patternmakers, molders and machinists. We always have vacancies. Address THE WESTINGHOUSE MACHINE CO., East Pittsburg, Pa.

WE do pattern work, turret lathe work, machine jobbing, build special machinery, with a modern equipment; also make fine machinery casting. McFARLAND FOUNDRY & MACHINE WORKS, Trenton, N. J.

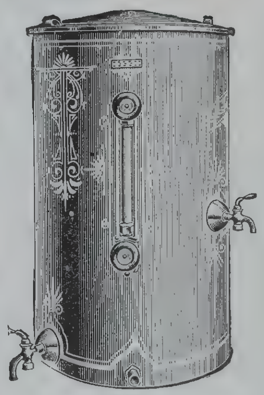
GALVESTON, TEX., September 13, 1902.

Burt Mfg. Co, Akron, Ohio.

Gentlemen:—Answering your favor of September 9th, we beg to state that the oil filter that we have purchased from you and installed on the 28th of May is giving us entire satisfaction and enables us to use the oil over and over again whereas formerly without it, we could not use the oil after it had once been used and discharged into the drip pans, etc.

It is difficult to state just how much we are saving at this time but it seems logical and safe to state that we would be using twice as much oil if we were without the services of your filter.

Yours truly,
TEXAS STAR FLOUR MILLS,
J Reymershoffer, Pres.



50%

90%

—?

Figure it out.

If one firm is saving fifty per cent. of their oil through the use of Warden Filters, and another concern estimates their saving at ninety per cent., how much will a Warden Filter save in your plant?

To facilitate the solving of this problem we will send you a Warden Filter, any size desired, on 30 days' trial—filter to be returned at our expense if the answer isn't 50 per cent. or better.

Catalogue shows all sizes.

The Burt Manufacturing Co.

Main & Howard Sts., Akron, Ohio, U. S. A.

Shelby & Co., London, E. C., England, Sole Agents for Great Britain.

ELYRIA, OHIO, December 11, 1902.

The Burt Mfg. Co, Akron, Ohio.

Gentlemen:—Replying to your favor of the 4th inst. we conferred with our Engineer at the mine, who informed us that he was greatly pleased with your Oil Filter, and that the saving in oil would exceed 50 per cent.; in fact he thought the saving at least 90 per cent.

We take pleasure in recommending your Filter.

Yours truly,
THE FLUSHING COAL COMPANY,
Per T. S. Faxon, **Pres.**

MACHINERY.

May, 1903.

SWAGING MACHINES AND THE COLD SWAGING PROCESS.

THE swaging process, although extensively used in certain classes of work is, as a machine shop operation, very little, if at all, recognized. The success, however, with which this process is employed for certain purposes would seem to indicate that its use might be applied with profit to a great class of work that is at present performed either by hot forging or by machining.

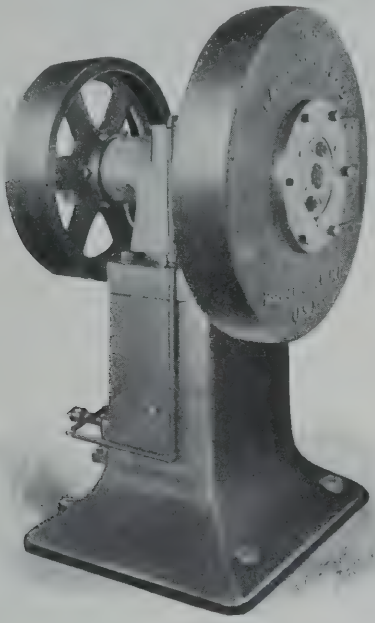


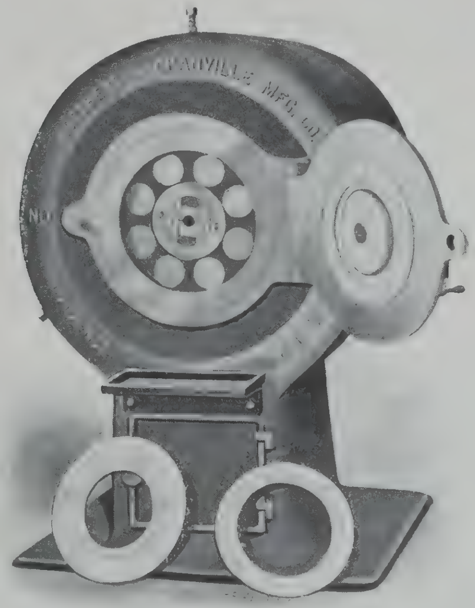
Fig. 1. Rotary Swaging Machine. (Langelier Mfg. Co.)

Cold swaging is the act of reducing or forming steel or other material while cold, such as drawing to a point or reducing the diameter of the work. This is performed by a machine which causes the work to be struck a great number of successive blows by a pair of dies of suitable shape to give the required reduction. The process is mainly applied to reducing wires, rods, and tubes, and is the only process by which rolled or plated stock can be reduced without destroying the plating or coating. For this reason it is largely used for jewelers' work, such as forming spectacle temples, fancy pins, and similar pieces. It is also extensively used for pointing rods or tubes which are to be drawn. It will put the best point known to wire drawers on a rod or piece of wire in a fraction of the time that would be required by any other method, and the same applies to its use on tubing. The millions of needles, bicycle spokes, button hooks, crochet needles, etc., which are turned out annually serve to show some of the possibilities of the swaging process.

As an illustration of the saving of stock that may be accomplished by the use of this process, we will consider a simple piece of rod which is tapered from full diameter to a small point, as shown in Fig. 3. In the view of the piece marked *A*, the dotted lines show the original piece of stock from which it would be made if the work were done on a lathe or screw machine, by the machining process, the dotted section showing the amount of material that would be wasted. In the lower view, *B*, the dotted lines show the amount of stock that would be required to produce it by the swaging process and there would be no waste whatever.

What were, without doubt, the original swaging machines were used in the Naugatuck Valley of Connecticut some time previous to the '60s, one of them at the works of Wallace & Sons, at Ansonia, and the other at the works of the Benedict & Burnham Mfg. Co., at Waterbury. The machine at the first named place was the design of Mr. George Doolittle, now deceased; while the latter was the work of Mr. George Somers, now president of the Bridgeport Brass Co. These devices were very simple, hardly rising to the dignity of machines, and were used as attachments to lathes. A block containing the stationary or bottom die replaced the tool post in an engine lathe. The top or reciprocating die was placed in the end of a lever whose opposite end was fulcrumed to a projecting arm of the block which carried the stationary die. A shaft with tappets on its periphery was mounted between the centers of the lathe and served to drive the end of the lever down, while a spring was used to throw it up after the blow had been struck. A stop was arranged to limit the upward motion of the lever. It will be seen that as the driving shaft was rapidly revolved, the arrangement presented a means for the bringing together and drawing apart of the dies in a rapid succession of blows. In one place this device was used to form a peculiar shape of cartridge shell, and in the other shop it was used for pointing the tips of lightning rods.

About 1860, two shopmates, O. L. Hopson and H. P. Brooks, invented a wire buckle. How to point the tongue of this buckle, became a problem with them and they began by the very obvious method of striking between dies which made the point; but the superabundant metal was thrown out in a flash or wing, at the joint between the dies, and these flashes had to be subsequently cut off. This led to a discussion of the possibilities of swaging a point by a succession of compressions, each so slight as to produce no flash or fin. Their first machine, a crude affair, was successful in its operation, and like many other inventions, it opened the way to a consideration of adapting the new principle to other uses. This called for improvements in the devices for forcing dies together, and Mr. E. J. Manville, a noted inventor, was called upon to devise improved means for producing the succession of compressions which, up to this time, had been accomplished on the trip hammer tappet principle and had been found objectionable on account of too great wear upon the parts. Mr. Manville happily hit upon the use of swinging cams, or detached toggles,



[Fig. 2. Rotary Swaging Machine, showing Dies and Rolls. (Mossberg & Granville Mfg. Co.)

For the historical portion of this article we are indebted to Mr. S. W. Goodyear, of Waterbury, Conn., and for the description of the horizontal swaging machine to Mr. W. D. Pierson, of the Waterbury Machine Co. The Langelier Mfg. Co. and the Mossberg & Granville Mfg. Co. have also assisted in its preparation by contributions of photographs and samples.

which, when the dies were driven together, constituted with them, as engaged in alternate pairs, the well known and powerful device, the knuckle joint. Here was a means of avoiding the use of the objectionable tappets and of putting the pressure required, really a crushing force, upon a good, broad concavo-convex surface capable of standing up under the pressure.

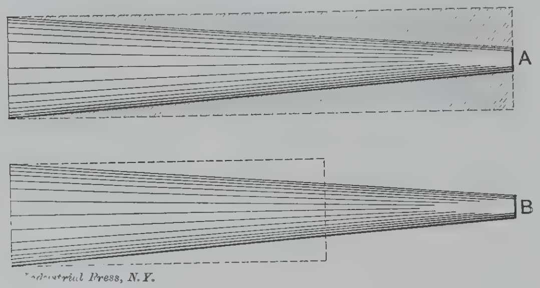


Fig. 3. Diagram Illustrating Saving of Stock by the Swaging Process.

The Hopson and Brooks machine, with the Manville improvements, soon came to the front as the machine *par excellence* for pointing rods and wires for drawing, finding its way into the wire mills for that purpose, as well as for use in many lines of industry in which articles of metal require to be reduced, tapered, or pointed, such as taper dowel pins, button hooks, marking awls, needles for sewing and knitting machines, and kindred articles. A very important field which the swaging machine occupied in its early development was that of furnishing the means for the production of drill rods to take the place of the well-known and justly-celebrated bright steel rods used for taps, drills, reamers, etc. This manufacture of American drill rods, beginning in 1867 by the use of imported steel, was continued in Connecticut until 1878. A leading American steel company, located in Pittsburg, Pa., then acquired the machines and patents and at once commenced the production of real American drill rod from their best special steel, an industry which is still continued and increased to very large proportions.

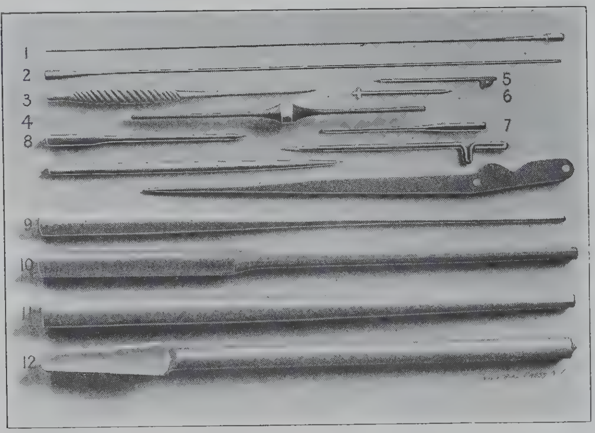


Fig. 4. Samples of Work Done with the Rotary Swaging Machine.

1-2. Spectacle Temples (Steel).
3. Fancy Pin (Rolled Stock).
4. Ring Body (Plated Stock).
5-6. Pin Tongues (Steel).
7-8. Machine Needles (Steel).
9-10-11. Cotton Machine Spindles (Hard Steel).
12. Bitt (Steel).

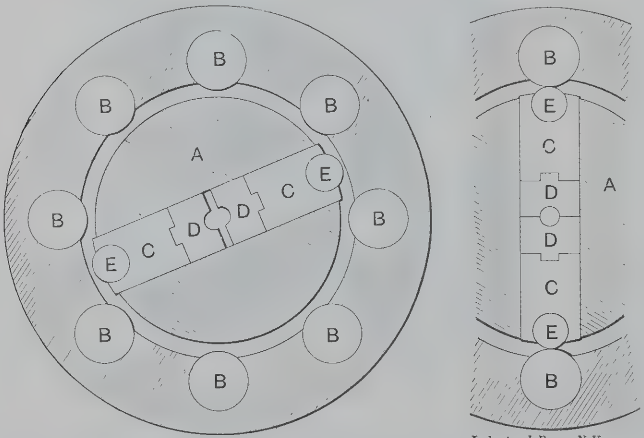


Fig. 5. Diagram Illustrating Principle of the Rotary Swaging Machine.

From these early developments swaging machines have come to be one of the recognized factors in mechanical production. They are now built upon two entirely different lines, i. e., those having the dies mounted in a revolving head, called rotary machines, and those having the dies mounted in slides, working horizontally, called horizontal machines. We will consider the construction and principle of the machines of each of these classes.

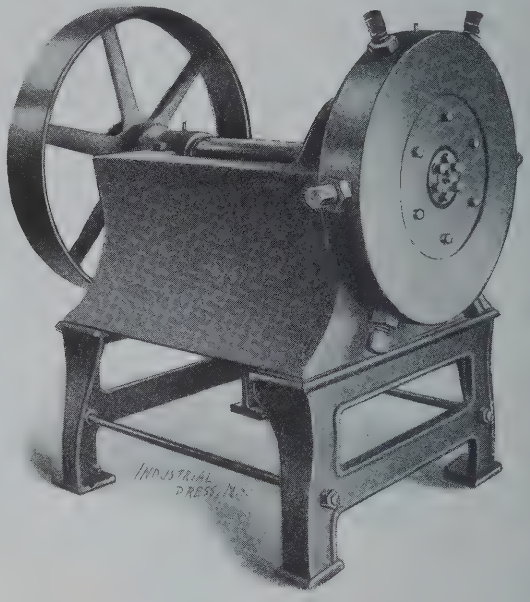


Fig 6. Goodyear Rotary Swaging Machine. Waterbury Farrel Foundry & Machine Company.)

Rotary Swaging Machines.

The rotary swaging machine is now being made by a number of manufacturers, and while the details of the different machines vary in some respects, the principle is the same throughout. Representative machines, made by several of the swaging machine builders, are shown in Figs. 1, 2, 6, and 7.

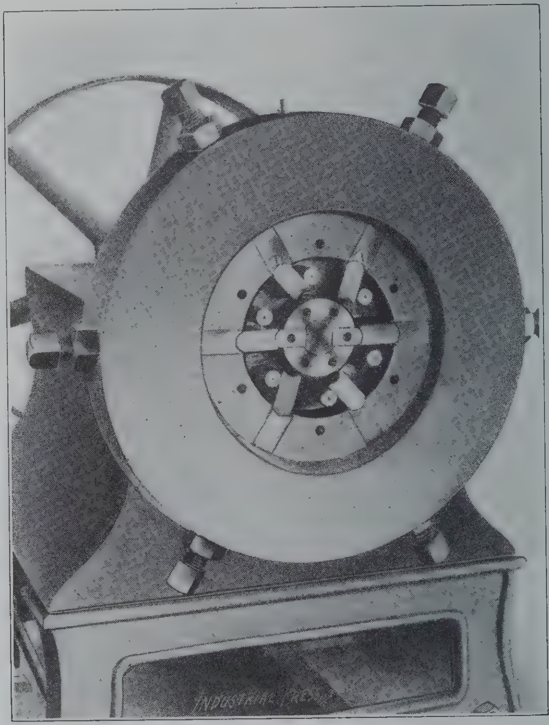


Fig. 7. Goodyear Rotary Swaging Machine, showing Arrangement of Dies and Toggles.

The principle of the modern rotary swaging machine is shown in the line drawing, Fig. 5. Inside of the head in which the spindle revolves is a set of hardened steel rollers, *BBB*, which are fitted in recesses in the fixed casting, each of them being free to run on its own axis. The front end of the spindle *A* is large and has a slot across its face in which the hammer blocks slide. These have recesses in their inner ends for holding the dies, *DD*, and in their outer ends are the rolls, *EE*, which are free to turn when they come in contact with those in the head. As the spindle revolves and the rolls in the die blocks are brought into contact with those in the head, the dies are forced together onto the stock. After passing a set of rolls, the dies are thrown apart by the action of centrifugal force, which keeps them separated until the next set of rolls is encountered, when another blow results. The machines are run at a spindle speed of from 400 to 500 revolutions per minute, and as there are eight rolls in the head, the result is from 3,200 to 4,000 blows of the die per minute. The work in these machines is not rotated, as the rotation of the spindle distributes the blows evenly around the circumference of the piece being operated upon. In the type of machine shown in Fig. 7, the rollers are replaced by oscillating cams which, when they come in line with the ends of the die blocks, form a powerful toggle joint and bring the dies together with great force. Adjustment is provided for by means of a series of setscrews which cause the wedges back of the cams to slide in toward the center. Some samples of the work done with the rotary machines are shown in Fig. 4.

Horizontal Swaging Machines.

The horizontal swaging machine was originally designed by Mr. John Henderson, of Waterbury, Conn., and the first machines were built by him. Later the manufacture was transferred to the Waterbury Machine Co., by whom this type of machine is now manufactured. The horizontal machine is especially designed for work of a heavy nature, such as is encountered in mills where rods and tubing are manufactured. It is constructed on an entirely different principle from the rotary machine. Fig. 8 shows a machine of this type. The round hole at the left, in line with the upper bearing, is the opening where the work is introduced. The center of this hole marks the place where the dies are split on the vertical line. One-half of the die is backed up directly against the heavy casting of the frame, and the other half, toward the bearing, has a reciprocating motion on the horizontal line. The means by which this motion is obtained will be seen by reference to Fig. 9.

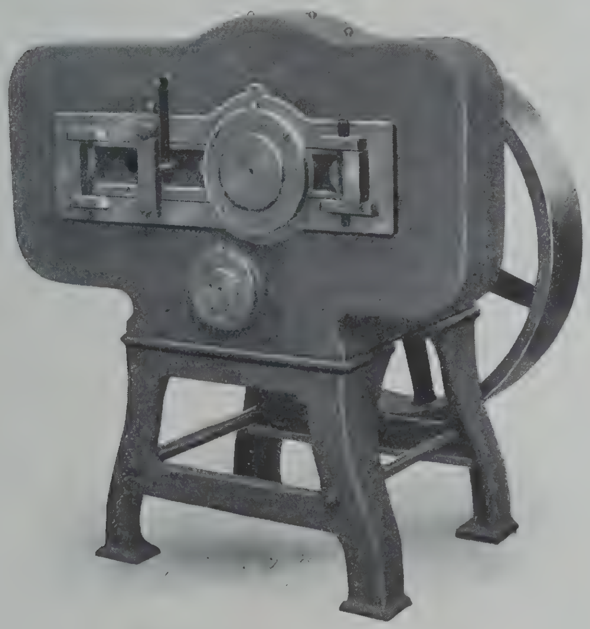
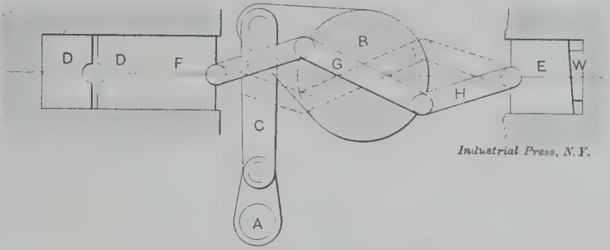


Fig. 8. Horizontal Swaging Machine.
(Waterbury Machine Co.)

The lower main shaft *A* carries the balance wheel and has a crank of short throw between the bearings, while the upper shaft, *B*, of large diameter, has a crank with a throw about six times as great. A connection *C* joins these two cranks, and it will be seen that if the lower shaft makes a complete revolution, it will turn the upper shaft through but a portion of the circle. If a line be drawn through the center of this upper shaft, so that it is horizontal when the shaft is in the middle portion of its turn, it will follow that this shaft will have a rocking motion about its center, and the diametrically opposite points where this line meets the periphery of the shaft on either side will each pass the center twice for every revolution of the pulley. If, now, a system of horizontal toggles be interposed between the reciprocating block and the frame casting at the right, in which system the middle block passes through the shaft, it will follow that by the rocking motion of this block the distance between the extreme ends will increase and decrease twice per pulley revolution, or, in other words, the number of blows will be twice the speed of the pulley. A spring, not shown in the cut, is used to separate the dies between the blows.

These machines reduce rods up to 2⅝ inches in diameter and tubes up to 4 inches, the amount of reduction ranging from ⅛ to ¼ inch for rods and ⅛ to ½ inch for tubes, depending upon the diameter and nature of the material. Where a much greater reduction is required than can be made by passing the work once through the dies, it has proved a great convenience to use a machine with three sets of dies, which gradually decrease in size. This is brought about by lengthening the machine out at the left hand end for two extra pairs of dies, and as but one pair is in use at a time, the motion is transmitted from one set to the other, all having a sliding fit in the opening. The form of the die is a cube, so that four faces may be used, as required, the dies being turned around to bring similar half openings together. When small diameters are required several sizes can be cut on each face, and the changing from one size to the other is but the work of a moment.



Industrial Press, N.Y.

Fig. 9. Diagram illustrating the Principle of the Horizontal Swaging Machine.

While the machine is principally designed to point rods and tubes for subsequent drawing through dies, it has numerous other uses, such as flattening round stock to a desired shape without waste of material. In this line it has been successfully applied to shaping ends of rods for screw driver blades, the round rod being merely pushed into the opening and the finished article withdrawn without any fin or waste. Many other operations of a similar nature may be performed, and in this class of work it covers a ground not practicable with any other type of machine.

* * *

The *Scientific American* describes an experiment to test the possibilities of propelling an ice boat by means of a rotary fan driven by a gasoline engine. The craft consisted of a platform 12 feet long by 4 feet wide, supported on runners and provided with a seat for the steersman. The boat was guided by a pair of ordinary bicycle handle bars while the levers for controlling the spark, the mixture and clutch were within easy reach.

The propeller, which is 4 feet in diameter, is mounted on a frame above the motor, which is a 2¾ horse power de Dion, connected with it by sprocket and chain. Its four blades are inclosed at the periphery by a flat band of their own width, riveted to them. This outer rim and the shape of the blades or pitch of the screw, are vital features of construction.

When the motor is started at slow speed and the clutch is thrown in, the propeller begins to revolve slowly, and gradually gains headway. As soon as it has attained a certain velocity of revolution, the sled starts slowly and gains speed, along with the propeller.

Only one model has been made, but this was successfully tested, and carried three full-grown persons at a rate of fifteen miles an hour. The inventor believes that a machine with twin propellers, operated by two 10 horse power motors, would easily make two miles a minute. At the trial the weight of even six passengers did not affect its speed. It seems to run just about as fast across or into the wind, as against it; but when it goes into the wind, the number of revolutions increases and the motor runs faster.

SHOP CONSTRUCTION.*—8.

POWER.

OSCAR E. PERRIGO.

In considering the question of power and its transmission to the different points in the plant where it will be required, we are confronted by a rather complex subject, and one which has been much discussed by many competent engineers in nearly all the mechanical journals during the past few years. The various methods and theories have had able champions in the special line in which they have been interested and rival claims have been ingeniously advocated to prove that they were the best methods to be adopted for nearly all conditions. One class have proven, to their own satisfaction at least, that while electricity is still in a very imperfect state of development and generally very imperfectly understood by a large majority of mechanics, it is to be the coming power for all purposes and may be used under nearly all conditions. Many of these claims have been well substantiated and the fact is that to-day there is a far greater and more general use of electricity in transmitting power than was thought possible even ten years ago. The ultimate limit to its usefulness no one can foresee. Again, the advocates of compressed air have shown that this has many advantages as an easily-transmitted and very useful power, and in its special sphere is doing very efficient and admirable work. New applications are constantly being found for it, and many operations formerly performed by hand are very much quicker, cheaper and better accomplished by its use. The sphere of its usefulness has broadened very much in the last few years and now we find it in nearly all up-to-date shops, for a large variety of purposes. In this it does not take the place of electricity, but rather is used in conjunction with it, or with steam power for the purpose of providing the compressed air, as may be most convenient.

The old-time mechanic is, however, apt to "pin his faith" to shafting and belts as the most reliable method of transmitting power, perhaps because he is better acquainted with this method; while the younger men are prone to argue the efficiency of rope transmission as the proper method. Many examples of efficient service by rope transmission might be cited, yet for the general purposes of a machine shop it is doubtful if it will ever replace leather belting. Recently the utility of transmission by chain has been revived and the interest in the subject very much increased by the improved forms adopted by later inventors. It is often exceedingly useful for the transmission of power within the limits of a single machine, formerly for operating feeds, and later for transmitting the principal power of the machine. Properly constructed, this system would seem to have a broad and practical field of usefulness in the future.

But all of these methods and systems, when reduced to the plane of practice in providing for the power plant of manufacturing concerns, are simply so many different methods of transmitting and distributing power, since it is to water or steam that we must look for our original power. We are confined, then, to these two sources of power—water and steam—and where the location does not provide us water power we must accept steam. Assuming the latter conditions in our manufacturing plant we must provide for steam as our source of power.

This having been settled, the best means of transmitting the power to the machines on the ground floor of the machine shop, to those on the gallery floors, to those in the tool room and pattern shop, and to the forge shop, foundry and carpenter shop, must also be considered. The question of boilers will naturally come first, and, in this connection, the type best adapted to the work; also the best method of setting them to produce the most efficient results. Next, the type and the dimensions of the engine, and the manner of its connections. And lastly, the method of transmitting the power to the machines to be driven.

In arranging our power plant we begin with the boiler room. We shall need a working capacity of at least 500 horse power. This may be distributed in a battery of boilers of 100 horse power each. One extra boiler is added so that in case of an accident to one of them, necessitating repairs, five of them may still be in proper working condition. Four of these boilers will be needed to run the engine, which leaves a margin of 100 horse power with which to supply the necessary steam for other purposes about the plant. Under ordinary conditions a sixth boiler may be added, giving 200 horse power for these purposes. By this arrangement there is the additional advantage that the boilers may be cleaned one at a time without shutting down the power.

The styles and types of boilers in the market are many and various, and most of them have good and practical claims to consideration in one way or another. But it is somewhat doubtful if any type will be devised that will become as popular for general use—or in the long run any more efficient and economical for hard, every-day service—as the return tubular type. Ofttimes the space in which the boilers must be located will determine the type, whether they shall be upright or horizontal; and the method of firing them, as well as the kind of fuel to be used must be taken into consideration. Mechanical stoking is used with success in some instances, but as yet has not come into general use. Both oil and natural gas as a fuel are much used in such localities as render them more economical than coal.

Our boilers will therefore be of the return tubular type, fired by hand, with the usual kind of soft or bituminous coal. They will be 66 inches diameter and 16 feet long, exclusive of the curtain sheet under the space occupied by the "up-take," or smoke connection. The arrangement for setting the boilers is shown in vertical, longitudinal section in Fig. 1; in a half vertical cross section, and half front elevation in Fig. 2, and in a horizontal section above the grate line in Fig. 3. There are several matters in connection with the setting of boilers which should be strictly attended to. Among these are the following: Two courses of bricks should be laid above the floor line of the boiler room for the boiler fronts to rest upon; the top course at least should be headers, and carefully leveled up. They should be so located that at least two inches will project in front of the boiler fronts. The ashpits should be cemented so as to allow of the introduction of a few inches of water. The front supporting brackets rest fairly upon iron plates in the side walls, while the rear brackets rest on rollers, which in turn rest on the iron plates set in the walls, by which arrangement all expansion of the boiler is toward the rear. The brickwork around the brackets should be entirely clear of them so as to leave the boilers opportunity to expand and contract without injury to the walls. The grates should incline from front to back from ¼ to ¾ inch per foot. The bridge wall should come up to within 12 or 14 inches of the bottom of the boiler, and be curved to suit its form, although this is not absolutely necessary. The width of grate surface should be equal to the diameter of the boiler. The side walls of the furnace are to incline outwards, so as to be two inches from the sides of the boiler, at a point one course of bricks below the bottom of the brackets. The fire bricks should be laid with a header course every five courses, so that burned-out bricks may be conveniently replaced. At each side of the fire doors cast-iron "cheek-pieces" should be put in, the cast-iron arch plate over the door resting on them. These "cheek-pieces" should be about 1¼ inches thick, of the form shown in Fig. 3, and have as many half-inch holes cored in them as possible, the holes spaced two inches from center to center, for an air supply to prevent them from burning out. Their height is equal to the height of the fire door at the side. They will be found to be very durable and to save much expense in fire brick repairs. They may be removed and replaced whenever the furnace is cool, by jacking up the arch plate a trifle and letting it down on the new "cheek-piece" introduced. Their inclined form renders the cleaning of the fire more convenient and the extreme front corner which they cut off is of little benefit in making steam.

Both outside and division walls should have a two-inch air space, as shown. The top of the boiler should be covered with asbestos, or with a brick arch. If the latter, there should be a two-inch air space left between it and the boiler. The boilers must rest only on the supporting brackets and in no case on the boiler fronts. The fronts are held in place by anchor bolts ¾ inch in diameter and four feet long, with the inner ends bent to a right angle 10 or 12 inches long. Their front ends are threaded for nuts coming outside of the boiler fronts, so that a defective or cracked portion of the front may be readily removed and replaced without disturbing the brickwork.

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* This concludes the present series, but another series by the same author, on shop equipment, will be published later.—EDITOR.

The smoke connections from the boilers to the stack may be the same width all the way through, in which case its height is to be increased from the first to the sixth boiler to include the additional area necessary for each boiler as it progresses toward the stack. Thus it may be 36 inches wide and 20 inches high at the first boiler, and increasing to 78 inches high at the sixth boiler. It will perhaps be more convenient to increase also the width in order that the area at the large end may equal that of the stack without increasing the height to such an extent. By this method we may make the larger end 48 inches wide and 60 inches high. There should be a cleaning door in the end of the smoke connection at the first boiler, and a pivoted damper properly balanced between the sixth boiler and the stack. It will be convenient also to have dampers in the "uptake" from each boiler to the main smoke connection, so as to shut these off whenever a boiler is laid off for cleaning or repairs.

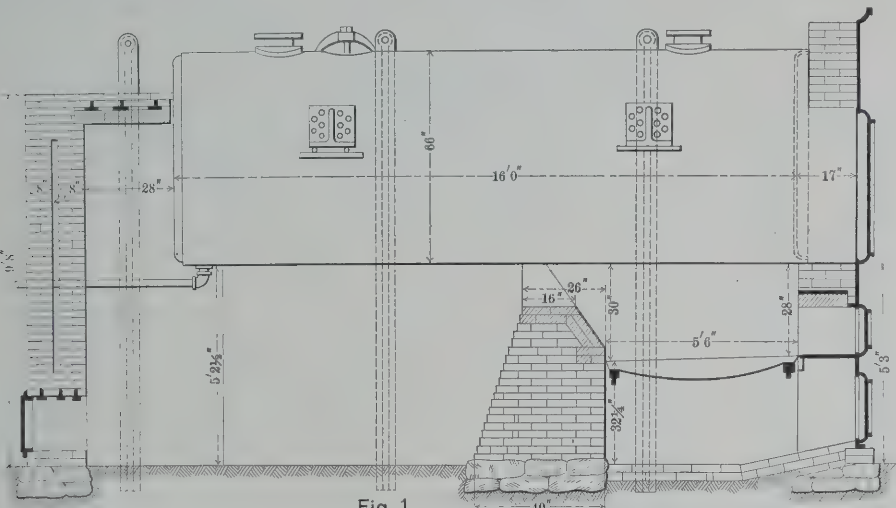

Fig. 1

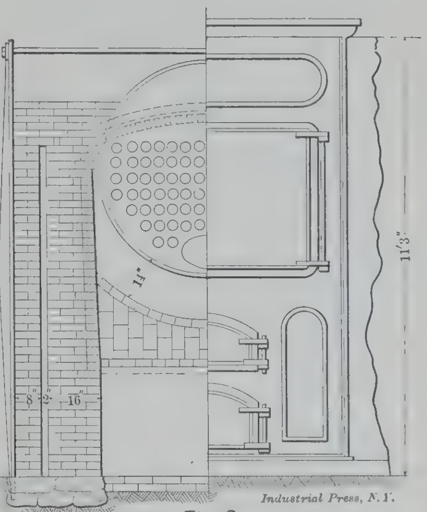

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Fig. 2

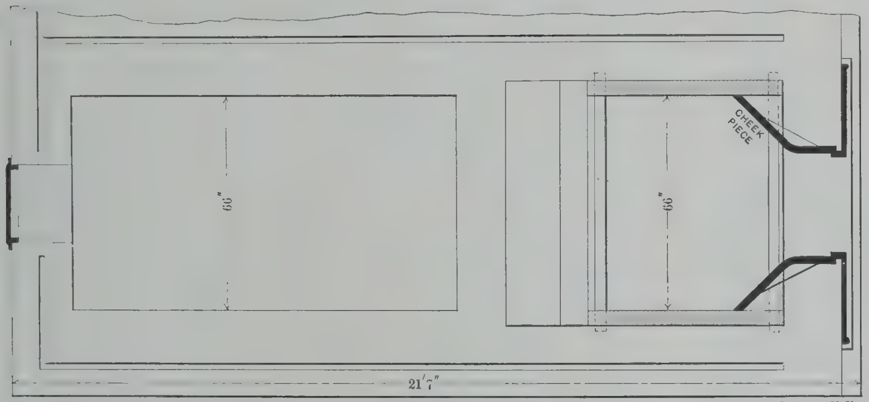

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Fig. 3

Boiler and Boiler Setting.

The steam connections from the tops of the boilers are to be so arranged that any one or more of the boilers may be "cut out" and the use of all the others continued. All steam pipes of three inches or over should be covered with an efficient and lasting non-conducting material. That containing a large portion of asbestos will probably be found the best.

The foundations for the boiler settings should be prepared in the same manner as for a machine foundation, as described in the article in the January number, due consideration being given to the weight to be supported, say about 1,200 pounds per square foot. The plan of boiler settings shown, that is, supporting the boiler on brackets attached to it, is the ordinary method. The more modern method, however, is to erect iron columns at each side of the boiler and upon these to lay I-beams, from which the boiler is suspended by iron rods, entirely clear of the brickwork, and with no part resting upon it. While this plan is no doubt correct in theory and practice, it is considerably more expensive than the method shown herewith and for that reason it may not receive the favor it deserves.

The general plan and arrangement of the boiler room with the boiler settings, the smoke connections with the stack, the coal-delivering tram track, scales, etc., and the engine room, with the location of the engine and its connection with the main shaft, is shown in Fig. 4, and in so far as it relates to the boilers and settings it is substantially the system adopted by the Bigelow Company, New Haven, Conn. As to the engine, it seems fairly well conceded that for economy of steam and general efficiency in furnishing the power for machine shop work the horizontal, cross compound condensing engine will be the best. This type of engine is made by a number of well-known engine builders, and while all of them have certain convenient features and peculiarities of design and construction which commend them to different purchasers, it is probable that there is no very great difference in their efficiency or economy in the general results.

The subject of gas engines has not been considered in connection with our plans as they do not seem suitable where a large amount of power is required, whatever may be their advantages in small or isolated plants.

Prominent among the builders of steam engines of the type referred to above are the Allis-Chalmers Company, of Milwaukee, Wis., and the William A. Harris Engine Company, of Providence, R. I., and it is this type of engine which is illustrated and described in this article, and commended for machine shop use. The size selected may be 16 and 32 x 48 inches, or 18 and 36 x 42 inches, with a balance wheel 18 feet in diameter with a 36-inch face, and capable of generating 400 horse power at 80 revolutions per minute and steam at 125 pounds pressure.

It will be proper to consider whether to drive direct from the engine to the machines by means of shafting and belts, or whether the engine shall drive dynamos, from which the electric current may be transmitted by proper conductors to motors, which in turn may drive main lines of shafting, or to a number of motors located in different parts of the works, driving short lines of shafting operating groups of machines, or again, whether we shall place a small motor upon each individual machine to drive it. All of these methods have their peculiar advantages and necessarily their disadvantages, corresponding to the conditions, the positions of the machines to be operated and the duty that is to be performed. Again we may profitably make use of compressed air for some of our work, as for instance, for drawing patterns, turning flasks and other portions of the lighter work of the iron foundry, as well as for the chipping room where hand chipping tools so operated are very convenient and useful. Hammers operated by compressed air may be used in the forge shop, since this force may be transmitted long distances with practically no loss such as steam is subjected to by condensation, and electricity by loss of electromotive force. Various operations in the machine shop also may render a supply of compressed air very desirable. This matter will be governed to a considerable extent by the kind of work to be done, or kind of machinery to be built.

It would seem best in theory as well as practice, and most efficient and economical, to avail ourselves of whatever good points each method possesses for the particular case in question, and, by using any of the different systems where the conditions are most favorable for its employment, to make the most of the useful and practical features and avoid as many of the difficulties and disadvantages as we may be able. For instance, while the practice of driving individual machines by separate motors may be said to be yet in its infancy, enough has been already done to prove its advisability in many ways, and to show that planers from 40 inches upwards may be profitably driven in this manner. The same may be said of lathes from, say 36 inches upwards, and also of the larger radial drills, vertical milling machines, boring mills, and, in fact, of most of the heavy machine shop tools. At the same time it does not appear to be as efficient or practical to apply individual motors to small machines when a group of them may be conveniently driven from a short line shaft run by one motor. The question of friction of the two systems of transmitting power, that is, from the engine by shafting and belting, or the loss of power by generating an electric current with which to drive motors, is one which has provoked much discussion. Probably it will be found in practice to be about as follows: Where the distance is short, shafting and pulleys are much the more economical. For distances of two or three hundred feet there will be little difference in the two systems. For much greater distances the advantages are in favor of the electric method.

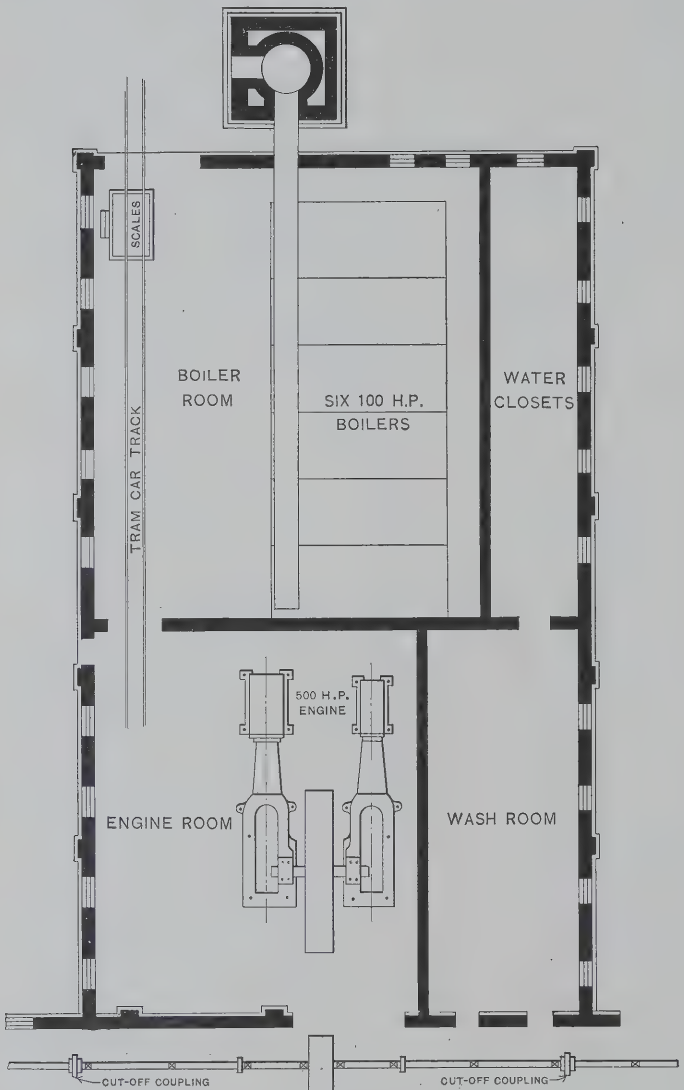

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Fig. 4. Plan View of Power Plant.

The plan of power transmission here selected is to drive from the balance wheel of the engine to a 72-inch pulley on the main line of shafting, giving a shaft speed of 240 revolutions per minute. This shaft is in lengths of 20 feet, supported by hangers every 10 feet, and with a hanger on each side of main driving pulleys. The three lengths in the center are five inches in diameter and the remaining portion each way from these three lengths is 3½ inches in diameter to the end. Cut-off couplings are provided on the main shaft at the points shown in the drawings, for the purpose of stopping either section of the shaft in case of accident. In the same manner, the shaft in the gallery over the main line has a cut-off coupling at each end of the section, upon which the main pulley is located. Shafting is frequently made at the present time on the odd sixteenth of an inch diameter, but the even sizes are here given for convenience. The shafts are provided with roller bearings, and all pulleys with the exception of the large main driving pulleys are of the pressed sheet steel form, as being the lightest pulley made for strength, convenience and transmission of power. From the end of the main shaft toward the front of the building, power is taken for the machines in the tool room. From near the center, power is carried by a vertical belt to the gallery floor above. This shaft is 3½ inches in diameter for the central 20-foot length and the remainder is three inches in diameter. Upon the central length, as well as on the main line below are pulleys 48 inches in diameter and 14 inches face. The central length is supported by four hangers—one at each end, and one on each side of the main pulley. In all cases the couplings are to be placed on the side of the hanger away from the source of power, so as to be secure in case of the failure of a coupling.

The dynamos for lighting, as well as those for driving the motors may be located in the engine room and driven by belts from the main line by friction pulleys, or they may be located under the main line shafting. It should be remembered that for a belt of high velocity it will be much better to run it horizontally than vertically, and that it will transmit much more power under the former condition. If it is desired to locate the dynamos in the engine room and run them by horizontal belts, a countershaft may be located near the floor, just inside the engine room and driven by a belt from the main line.

An independent engine may be used to drive the motors. In this case the power of the main engine would be considerably reduced. The main line shaft furnishes power for all machines on that side of the main floor. The machines on the opposite side of the main floor may be those which it is desired to drive by individual motors, while in the gallery above, the line shaft, in, say three or four sections, may be driven by suitable motors. The same method may be desirable in the pattern shop and also in the tool room, if preferred, although it is more adaptable in the pattern shop where power is not used continuously. The power for driving the machines in the carpenter shop may be transmitted by belt from the main line through a belt box occupying the space between the machine shop and the carpenter shop to the line shaft in the latter. Or, a motor may be located in the carpenter shop.

If a steam hammer is used in the forge shop the steam supply should be carried in a pipe passing through an underground brick conduit, as carrying it around through the machine shop and carpenter shop would necessitate a long line of piping. A motor will be most convenient for operating the blast fan, drop hammers, cutting-off machines, power hack saws, etc. For the foundry, steam may be carried under ground, across the yard in a brick conduit, as the most direct way, to the engine running the heating apparatus, and another for the cupola blower and the tumbling barrels. Here again motors will be very convenient, as one may be directly connected to the heating apparatus fan and another used for the cupola blower and the tumbling barrels, as well as to run the elevator which supplies the cupola platform with its fuel and stock.

MANUFACTURING ARMATURE DISKS AND SEGMENTS.

JOSEPH V. WOODWORTH.

The adoption and use of dies, power presses and special sheet-metal working machinery for the economic production of parts of electrical apparatus has had great development during the past few years; so that to-day establishments that manufacture sheet-metal working machinery dispose of a great portion of their product to electrical machinery manufacturing concerns. One has only to examine an electrical device or a machine to realize what a factor the power press has become in their production. The parts of electrical apparatus for the production of which such machinery is used most extensively, are armature disks and segments for motors. It is at once obvious that the requirements for such work have led to the designing of dies, presses and special machinery, which differ in essential details from those used in the general and more familiar classes of sheet-metal working.

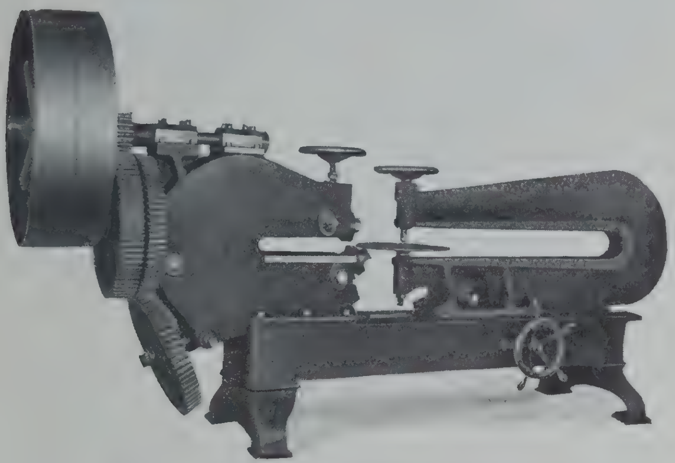

Fig. 1. Circular Shear for Inside and Outside Cuts.

An armature consists of a wired "core" composed of thin sheet-iron plates or disks averaging from .010 to .040 thick and from 10 to 100 inches in diameter. In many of the best armatures the disks are produced by punching the center hole, keyslots and notches, or winding slots, simultaneously at one stroke of the press. The small sizes are thus produced in dies, while the larger ones are produced in sections or segments of as large size as it is possible to procure iron for. In the cheap and inferior armatures the disks are first punched from plain sheets; the punching of the center holes and the key-slots is a second operation, after which the disks are assembled on shafts, the outside turned to the required diameter and the slots milled on a universal milling machine.

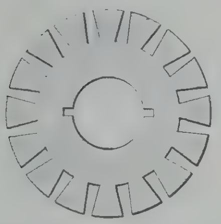

Fig. 4. Disk Produced at One Stroke in a Compound Die.

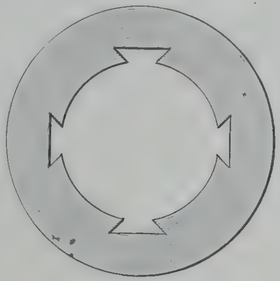

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Fig. 6. Disk Blank before Notching.

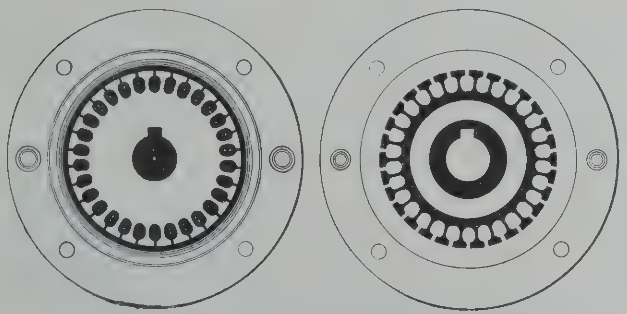

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Fig. 5. Plan of Compound Die and Punch.

Machines and dies used for cutting and perforating armature disks and segments differ according to the size and shape and number or quantity required. There are in general use four methods for cutting armature disks. On the size and quantity of disks desired depends the practical value of each.

Disks of very large diameters or those required in relatively small lots, are usually first cut plain by shearing the outside circle and afterward the inner circles on circular shearing machines of the type shown in Fig. 1. As shown, the lower cutter is in an angular position relatively to the upper, so as to permit the making of as clean a cut on the inside as on the outside. Disks cut in this manner are afterward notched on an automatic notching machine of the type shown in Fig. 2. A plain blanking or notching punch and die are located in the press portion at the left and a circular disk clamped between the two pads of the indexing and revolving mechanism at the right. The indexing is entirely automatic, the spacing and number of notches in a disk depending on the arrangement of the gearing.

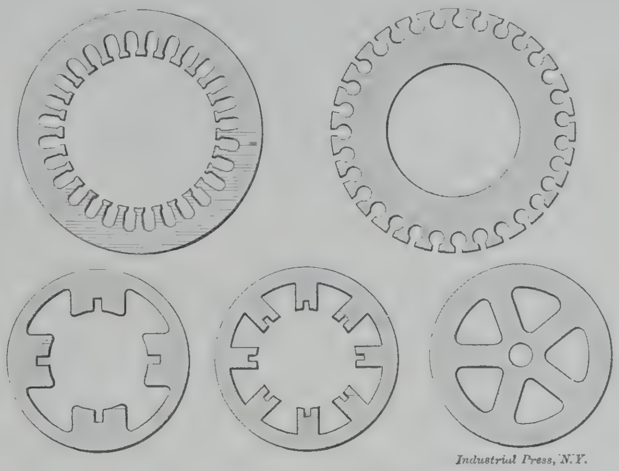

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Fig. 3. A Group of Armature Disks.

In this machine the adjustment for different diameters is made by simply turning the handwheel shown. The adjustment for different numbers of notches is effected by means of the change gears shown, instead of a pawl and index plate device as is usually employed. Each set of gears can be arranged to answer for three different numbers of notches. The index feed is effected by means of a "Geneve" stop movement, but absolute correct indexing is assured by the use of a positive cam-actuated locking device for the indexing arbor.

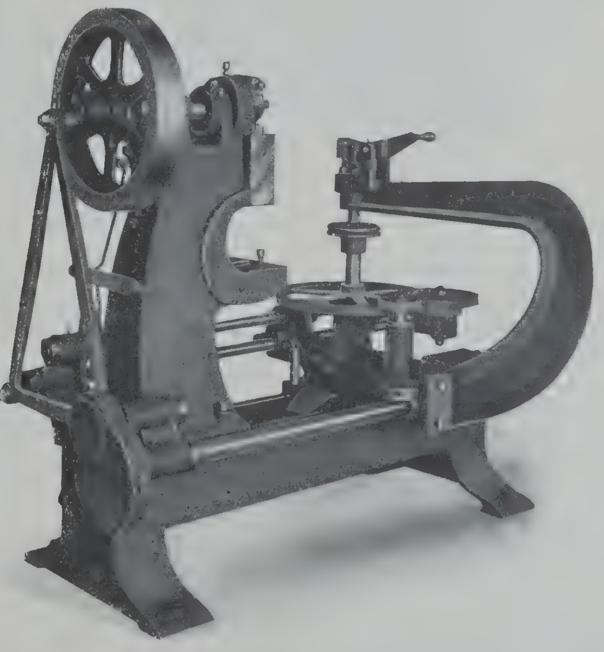


Fig. 2. Automatic Armature Disk Notching Machine.

In connection with the punch and die used in a machine of this type a spring stripper is used, so as to leave a clear space above the die, making it easier to introduce a new disk, and at the same time provide for holding the disk under pressure when the notch is being punched. This, consequently, obviates the necessity of using a clamping plate over the center of the disk.

When disks of the polyphase motor type, having holes or notches punched in the inner periphery are required to be notched in a machine of this type, it is necessary to do the notching before the large inner circle is removed, as its surface is needed for carrying the disks in notching. In such disks one or two small holes are previously punched in that portion of them that is afterward cut away, in order to serve as guides in the notching and center-hole punching operations.

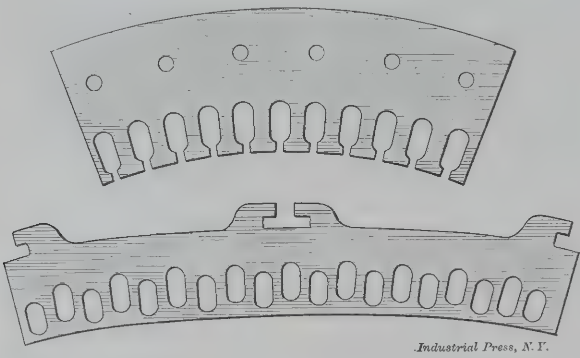

Industrial Press, N.Y.

Fig. 7. Armature Segments.

The kinds of disks which are of moderate diameters and most frequently required in large quantities are those used for street car motors. To produce them powerful power presses are used. These presses are equipped with dies so constructed and arranged that the inside of the disk with its key-slot, and the outside with its notches are cut simultaneously at one stroke, as shown in Fig. 4. This method constitutes the quickest, most accurate and economical way of manufacturing armature disks in large quantities. The presses in which such dies as are necessary for such work are used, are provided with knockout attachments which discharge the scrap and the disks so that they lay loosely on top of the dies, thus allowing of their easy removal.

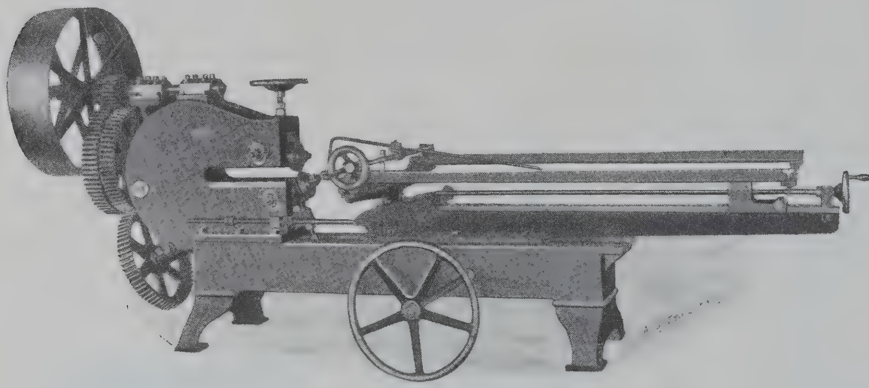


Fig. 9. Circular Shear with Segment-cutting Attachment.

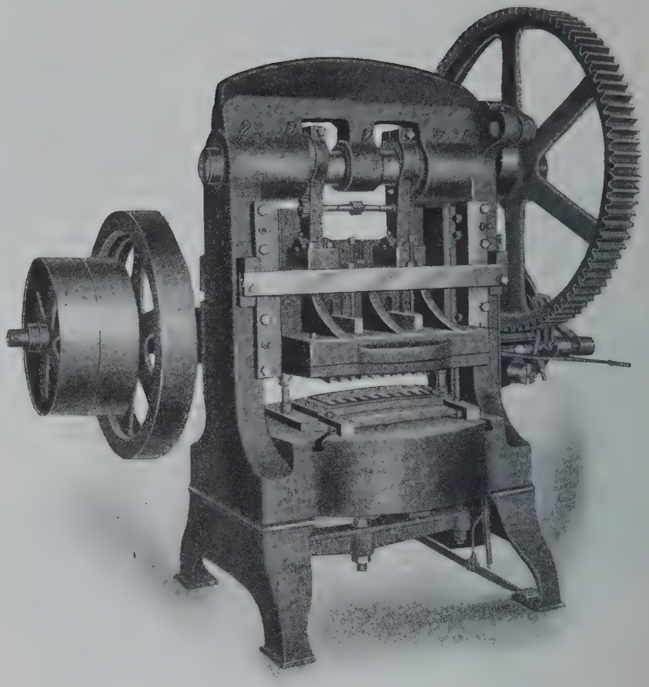


Fig. 8. Automatic Disk-notching Press, Equipped with Positive Knock-out Devices for Punch and Die, and Automatic Friction Clutch.

In regard to the power presses used for disk punching, it may be stated that the requirements of armatures for electric work have led to the construction of presses which differ in points from those used for other styles of sheet-metal working. As it is always essential to have the outside and inside exactly concentric, so that all notches in the disks shall coincide perfectly with one another when assembled in "cores," it has been found best to adopt dies, which, by being cut simultaneously, eliminate the inaccuracies which are well-nigh unavoidable when the cutting is done in two or more operations. In many cases, the notches and key-seats are also punched at the same time. To accomplish these results in one operation dies of great accuracy are required, which, in addition to the cutting parts, must be equipped with "knockout" pads that will automatically deliver the punched disks and scrap from within the dies. The dies used in these methods of producing the disks are known as "compound dies," and are usually built up in sections which have been hardened, ground, and lapped to size. However, not infrequently they are made in the usual manner, but the results are not so accurate. These compound dies are very expensive, costing all the way from $150 to $1,000 each. Fig. 5 shows plans of a compound punch and die. As a rule these compound dies are used in presses provided with upper and lower die knockouts, thus obviating the necessity of the strippers in the dies. The die sections are located in a steel casting. The rings are of tool steel, carefully and accurately worked out, hardened and ground to size, while the remaining ones are left soft. The dark sections in the figure indicate the cutting parts.

As the installation of the above described method entails a great deal of expense, and can only be adopted economically where disks are required in large, steady quantities, it is at once apparent that the dies would be too costly to use for producing disks in small lots. For this reason another method is in vogue. This method consists of cutting out simultaneously the plain outside and the hole, as shown in Fig. 6, and then punching the notches on a notching press. By this method a perfectly concentric blank is produced ready to be notched. As by this method the outside notches are cut separately, the power of the presses in which the work is done is equal to much larger diameters than those used in the method before described.

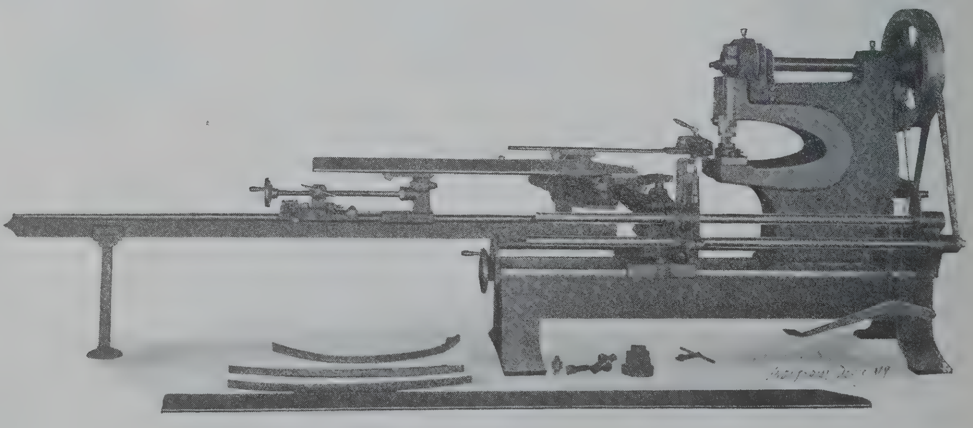


Fig. 10. Armature Segment Notching Press.

In producing very large disks there is a great deal of scrap, but this scrap is prevented from going to waste altogether by being worked over into disks of smaller size. From the inside scrap, the projections corresponding to the key notches are removed by forcing the disk through a circular trimming die, which punches the center hole at the same time, and thus, no great waste of stock is entailed.

In manufacturing armature segments in very large quantities the outside and the holes are usually cut simultaneously in dies in which the stripping of the scrap and the segments from them is entirely automatic, for both the upper and lower sections. A press specially designed and used for this class of work is shown, equipped with proper tools, in Fig. 8. The cutting of sections and segments complete with dovetails, and all notches and holes up to thirty-five, ¾-inch long, can be done on a press of this sort. However, most segments of large size are first punched plain and the notching and perforating are done in succeeding operations.

When the plain segment blanks are not produced in dies, a circular shear of the same type as that used for disk cutting is used, it being equipped with a segment-cutting attachment, as shown in Fig. 9.

In Fig. 10 we have a side view of an armature segment notching press. The segment notching attachment on this machine allows of handling segments having a radius of from 36 to 96 inches and up to 36 inches in length. The manner in which the segments are notched is as follows: The segment to be notched is clamped in a holder at the forward end of a long radius bar, and is traversed across the die face by means of an indexing mechanism and change gears similar to those on the regular disk notching machine shown in Fig. 2. When the segment has been notched all around its outside or inner edge as required, the press stops automatically. After the operator releases a hand lever the segment may be returned to its original position and removed from the press.

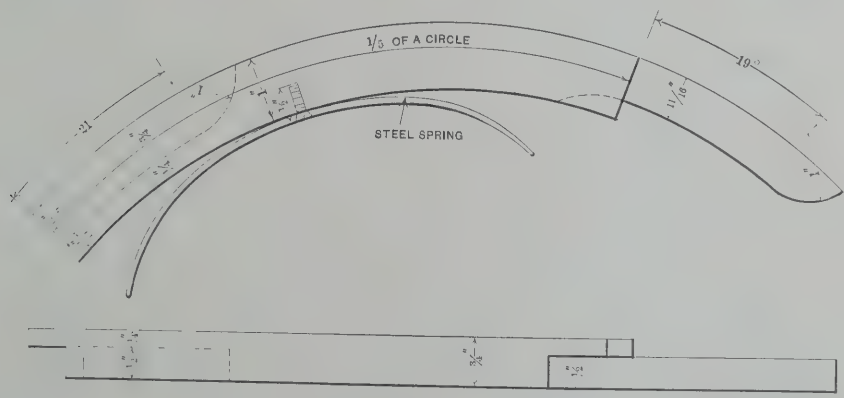
* * *

PISTONS AND PACKING RINGS.—4.

UNION IRON WORKS AND ST. JOHN'S PISTONS—A DESIGN BY THE AUTHOR.

J. H. DUNBAR.

With this article, I have the pleasure of showing the readers of MACHINERY a piston and rings as made by the Union Iron Works, of San Francisco, Cal. Mr. W. G. Dodd, vice-president of that company, kindly sent me a blueprint of the piston, and he says they consider it a very good type, for horizontal engines up to, say, 24 inches diameter. For larger engines, they use set-out springs. I enclose the blueprint as I received it, and ask the editor to mark the figures; "Union Iron Works Piston."



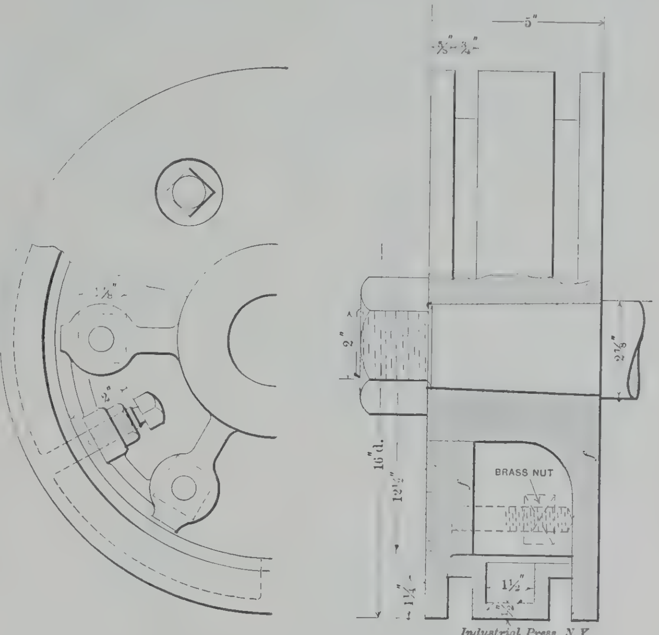
Industrial Press, N. Y.

Fig. 2. Piston Ring of Union Iron Works Piston.

It will be remembered that the famous battleship, *Oregon*, was built by the Union Iron Works, and while Mr. Dodd did not say that the pistons in the engines of this celebrated vessel were of the type shown in the print, it is quite probable that they are. There is nothing to prevent them from being practically steam-tight, and nearly frictionless, and it goes without saying that if pistons have these two virtues and can be relied on always to possess them there cannot be much wrong with them.

It sometimes happens that like engines do not give like results, which is usually due to a difference in the conditions under which they have to do their work, rather than to any dissimilarity in the engines. In the case of the *Oregon*, the management, men and machinery were all of an equally high order, and this combination of forces pushed the name of that vessel to an altitude that made it visible to the entire world.

Referring to the Union Iron Works piston, the reader will note the double lap joint of the packing ring, which is a new way, at least to the writer, of cutting them. The body of the ring has a radial dimension of 1 inch and is ¾-inch thick. To form the joint, one end of each section of the ring is milled down till it has a cross-section of ½ x 11-16-inch, leaving a tongue about 20 degrees long. A corresponding slot is milled in the other end of the section. It will be seen that the radial depth of the slot is not uniform, but increases in depth from 11-16 inch at the end of the section. to ¾ inch at the end of the slot. The object in making the joint in this way, is probably to allow the sections to adjust themselves in the cylinder, without cramping the tongues, which cramping would be likely if new rings were to be put in an old cylinder that was worn out of round without some way of compensating for the cylinder's irregularity. It seems to me that a like advantage would be gained in milling off the outside of the tongue, beginning at the heel of it with nothing, and take off say 1-16 at the point, which would very materially increase the diametrical flexibility of the ring at its joints. Machinists, who have had fun trying to loosen follower bolts, and who finally, after twisting them off, have had to drill out what was left in the spider, will appreciate the brass nuts for the follower bolts. As no dowel pin is shown in the blueprint, we may presume that the rings can go around in their grooves as they please. Where the type of ring (as it does in this case) and the roundness of the cylinder permit it, I have found it to be beneficial to both ring and cylinder to let them change relative positions. It prevents any tendency for them to "tongue and groove" each other. If the ring requires to be doweled, it should be allowed, say ½ inch cylindrical play in the groove, to change its situation.



Industrial Press, N. Y

Fig. 1. Union Iron Works Piston.

In looking through my notes, sketches, catalogues, etc., I find a circular of the St. John Cylinder Packing Co., and I want to say that I do not think that any company making cylinder packing rings, ever had their rings so highly recommended by so many prominent firms and individuals. To represent the high standing of the firms, I will say that it is claimed that Brown & Sharpe, after trying the St. John packing in one of their engines, put it in all the engines they had. To illustrate what this packing does, I quote a part of a letter from the general superintendent of the Staten Island Rapid Transit Railroad Company: "The result is a saving of about 10 per cent. in fuel, 75 per cent. in cylinder oil and a great improvement in the cylinders, which are now worn very nearly true, although they were in very bad shape before the change in packing was made." While it would take a whole page or more of Machinery to print names and addresses of parties using this packing, and at least a page for letters of recommendation, it is but fair to say that not an engine builder, or steam railroad company's name is on their list. There are, however, plenty of names of builders of steam boats, tugs, battleships, etc.

I remember being favored by a call from a representative of this company, about ten years ago; if I am not much mistaken, it was Mr. St. John himself. He represented with fluency and ease, that his pistons were absolutely steam-tight, frictionless, required no attention, and but a minimum quantity of oil, and would true up a distorted cylinder in good shape in a short time. Then he showed me the long list of his customers, and read letters from some of them. He kept on talking of the phenomenal success of his rings, and at the same time sharpened his Faber, and produced his order book, and asked me to give him the dimensions of the piston for the worst cylinder that I could pick out. Before giving the sizes asked for, I begged the privilege of inquiring into some of the cylinder-truing features of his rings, a favor which he readily granted.

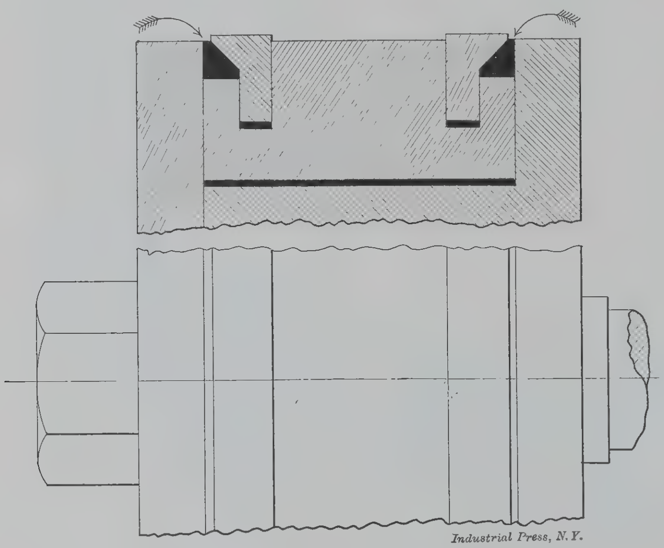

Industrial Press, N. Y.

Fig. 3. St. John Piston and Piston Rings.

"Is it necessary to make any change in the steam distribution of the engine, while the rings are truing up the cylinder?"

"No. It does not make any difference to the rings, how you use the steam in the cylinder. It's the rings that true the cylinder, not the steam."

"What do you make your rings of?"

"The best cast iron that we can buy."

"If the iron in our cylinder should happen to be somewhat harder than that in your rings, would that fact make any difference in the cutting action of the latter?"

"No." (Order book disappears.)

"Some of our larger cylinders are perhaps ⅛-inch smaller in the middle than at the ends. As your rings shave this surface metal off, is there not danger of its lodging somewhere, in its passage from the cylinder, and giving us subsequent trouble, as it might do if it was caught between the slide valve and its seat?"

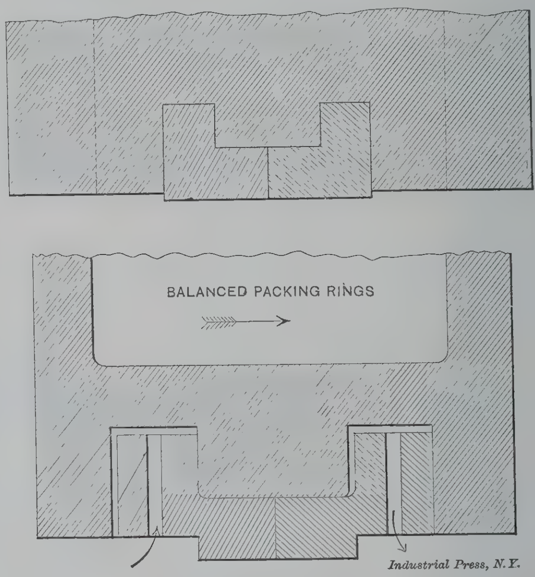
"I have never heard of a case where anything of this kind happened." (Pencil disappears.)

"When your packing has un-humped a cylinder, how do you prevent it from continuing to make a general enlargement of it?"

"That question is very irrelevant, and I must refrain from further trespassing on your time." Then he disappeared, with a smile and a "Glad-to-have-met-you" good-bye, just as if nothing had happened. The next day, which was Sunday, I had the pleasure of listening to him preach an excellent sermon at Trinity M. E. church in this (Youngstown, O.) city. I simply state the facts in this most unusual occurrence, and leave the reader to do what he pleases with them.

St. John's pistons are of the bull-ring type, but I see no reason to prevent his using a single-piece piston if he wanted to, as his only visible feature not common to pistons in general, is the beveling of the outer edges of his packing rings. Fig. 3 is a copy of the cut in his circular—shading, arrows and all. The arrows, of course, show how the steam gets under the lip on the rings and sets them out to the cylinder. It is scarcely necessary to say that the object now is to keep the steam out from under the ring, and let its inherent elasticity do the setting out. There does not seem to be any reason why this piston will not perform all the functions that pistons are expected to, but to imagine that his packing rings will do the boring mill act, is to expect the impossible. There is nothing in the shape of this ring that will true out a distorted cylinder; in fact its shape has no advantage in any respect that I can see over a ring having a prismatic cross-section.

In the upper section of Fig. 3 A is shown St. John's rings reversed in their grooves. Instead of beveling their edges, I leave them square so they can butt up together in the center of the piston. This disposition of the rings would allow the head to be shortened up, as indicated by the vertical dotted lines. This style of packing would also prevent any cylinder wear on the piston, and would, I believe, reduce its steam load to a minimum. Then there can be no step wear on the cylinder, as shown in Fig. 8, of December, 1902, Machinery. It will also be noticed that the two rings are equal in breadth to the space between the rings in the upper section, so that the piston is supported by like areas in both cases.



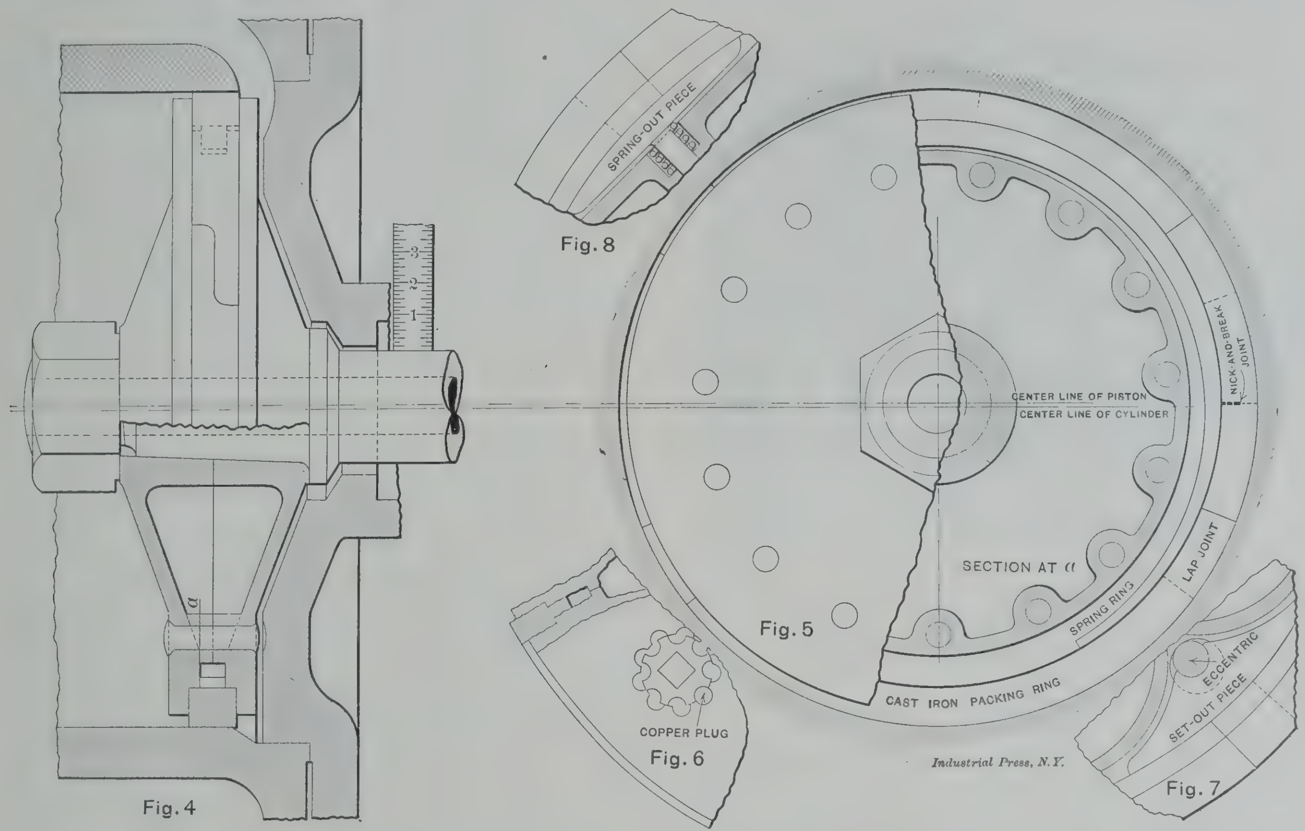
Industrial Press, N. Y.

Fig. 3A. Suggested Modification of St. John Piston.

I do not see why we may not follow this same line of reasoning further, and relieve the rings themselves of any but a minimum steam load, by making a negative bevel (calling St. John's positive), on the outside of the rings. As a bevel is objectionable owing to the ring's breadth varying as it wears down, it will be best to scoop out the whole corner, as far back as it would have been beveled, and then we have the same ring area from start to finish. The lower part of Fig. 3 A shows the outside corner of the rings cut away as stated, and it is easily seen that the ring is perfectly steam-balanced in a radial direction; and it is desirable to have it unbalanced in a longitudinal direction, in order that the ring can move sufficiently to make a tight joint with the edges of its groove. But suppose that some steam does leak past, or around the ring, it has an easy way to escape via the radial holes in the right hand ring, as shown by the arrow. Thus it is seen that there is no possible chance for steam to act in an unbalanced radial direction on the rings, with an appreciable pressure. Here we come abruptly to the end of the string which we have been following, so far as theory is concerned. As to matter of detail we may say that the rings should be loosely doweled, with their joints inside of the arc of contact with the piston, so that no leakage will occur there. An annular tongue on the piston, and a single flanged ring, with a lap cut, kept at the bottom of the cylinder, and the piston would be reduced to its lowest terms, as regards simplicity. Of course, if the ring travels over the counterbore at the ends of the cylinder, it must have lipped edges to keep it from collapsing, at the ends of the stroke.

Before closing the discussion of rings and pistons combined, I ask to be allowed to revise the piston shown in Figs. 6 and 7, of my article in Dec. MACHINERY. I have worked the design over carefully, with a view of adapting it to locomotives, as well as horizontal stationary engines. It is shown in Figs. 4, 5, 6, 7 and 8.

The piston is made of two steel castings, riveted together near its circumference, and clamped between the nut and collar of the piston rod at the center. The flanges are turned about 2 per cent. smaller in diameter than the cylinder, and is intended to be run as much above the center of the cylinder, when it is started new, as it is permissible to run it below the center. This way of starting with a new piston, or ring, gives double the wear without adjustment, or getting farther from the center of the cylinder than the usual way of starting with the piston in the center of the cylinder. The scale set on end on top of the piston rod, when the piston is at the crank end of its stroke, is intended to be used as a pointer to denote the whereabouts of the piston in the cylinder, without the trouble of taking off the cover. For the smaller sizes of pistons, say 20 inches and under, the packing rings are very similar to those described in December MACHINERY, except the "uplift," making the outside ring in sections, so as to give it ample groove contact, when the piston's flanges are cut down. The narrow, eccentric inside spring ring is to set the outside ring out to the cylinder, and also to prevent an objectionably large area for the steam to act on, on the inside of the outside ring. Both rings are to be doweled in the positions shown in Fig. 5. The points of the inside ring will have to be cut off, to allow it to be snapped into its groove without breaking; but as the piston rests on the outside ring for one-third of its inner circumference, there is no need for the inside ring to be but little over two-thirds of a circle. It will be necessary to make a lap joint in the outside ring at the top, to prevent leakage there as the ring wears; but the others may be nick and break joints, which consists only in sawing part way through from the inside of the ring and breaking the rest.



Improved Design by the Author for Piston for Locomotive and Stationary Engine Practice.

For pistons of large diameter, the ring is made having a cross section to fit both grooves, and the sections set out to the cylinder, the same as the Corliss packing, which I now show in Fig. 8, the spring-out piece being placed under each joint in the sections. Where it is desirable to keep the piston close to the center of the cylinder, I show a simple method in Figs. 6 and 7 of setting the ring out at the bottom of the cylinder, and consequently raising the piston. The piston head is milled out, as at Fig. 7, which is a section at *a*, Fig. 4, to receive a set-out piece which fits over the small part or middle journal of an eccentric shaft, thus keeping the shaft from working endwise, the shaft being journaled in each side of the piston. Fig. 6 is an end view of the shaft, at the face of the piston, and shows that it is kept from turning by a copper plug driven in holes drilled half in the head, and half in the shaft. When adjustments are required to be made the plug is drilled out, or sheared off, by turning the shaft. When the shaft has been turned to a position which supports the head at the center of the cylinder, some of the half holes will match, so that another plug can be driven in, to secure the position.

* * *

The extravagant predictions regarding the inexhaustibility of the Texas oil fields have quickly been shown to be false. Many of the wells have ceased flowing and have to be pumped. The production has fallen away so that many concerns in the South that were equipped at much expense for burning fuel oil have torn out their oil burners and have gone back to the use of coal. At one time oil sold in the Texas field as low as 14 cents a barrel delivered at tidewater, and even cheaper; now it is 90 cents a barrel and the price is still going upward. The Standard Oil Co. are discouraging the use of fuel oil in manufacturing plants in the North and are refusing to make new contracts for supplying oil to manufacturing plants for a reasonable price as they insist that the supply is becoming so limited as compared to the demand that it is much more profitable for them to refine it. This is most unfortunate, as there are certain kinds of apparatus that cannot be successfully used with any other fuel except a rich gas, and to make the gas it is necessary to use petroleum. The general use of oil fuel for locomotives and steamships seems remote.

THE MAGAZINE HABIT.

W. H. SARGENT.

A trade paper is not unlike a group of workmen who get together in the morning before the whistle blows and talk over their experiences in the shop and among their tools. Eventually the group becomes so large and is so widely scattered, that what the Christian Scientists call "absent treatment" must be resorted to, and every man who has an idea or an interesting experience writes it to the editor who sees to spreading it among the other workmen. Sometimes half a dozen of these men will band together and form a magazine club, each one subscribing for a different publication, but all sharing the expense equally. These magazines are then passed from one to the other around the club so that eventually each has the opportunity of examining all and can read or skip as suits his taste. Like books "some are to be tasted, others to be swallowed, some others to be chewed and digested." Too many magazines, even of the best, are of no advantage to a club. "The possession of books is not an education any more than the possession of tools is a trade." Occasionally a man will declare that his trade paper is of no use to him; that he could edit a better paper himself. Now the editor is not "A small unbound edition of Moses and Solomon both," and occasionally an assertion will creep in which is not authorized by facts, or perhaps something will be printed as new which is a well-remembered fact to some of the older readers, but in spite of this a vast amount of really interesting and useful knowledge is being printed by the technical journals.

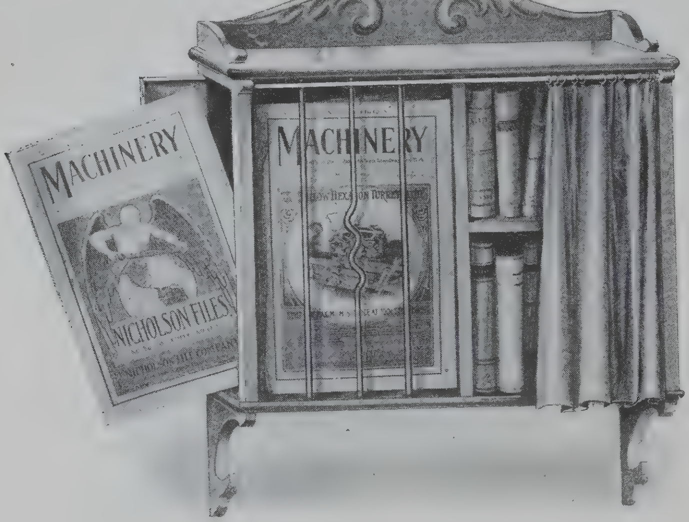
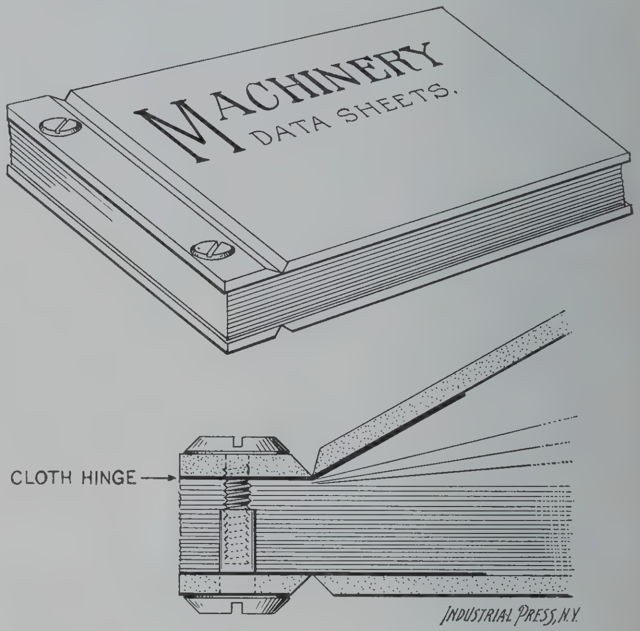


Fig. 1. Bookcase for Magazines.

Next to knowing a thing is knowing where to look for it. Since no one remembers all that he reads, many people keep a card index of the articles likely to interest them. Sometimes these articles are cut out and pasted onto the cards which are then grouped under appropriate headings. Others, rather than mutilate the magazine, make a note on the cards, of the volume, number and page, and file the magazine away for reference. In this case the periodicals must either be bound or kept in such manner as will insure their being found when wanted. Most of the mechanical journals are of large size and do not file away conveniently in a bookcase since they project out into the room more than books of ordinary size. To accommodate books of the size of MACHINERY, the writer has designed a bookcase in which the large books are inserted at the end of the case, flat against the wall, while books of ordinary 12mo and 16mo size go in from the front in the usual way. This bookcase is illustrated in Fig. 1, and may, of course, be two or three shelves in height, if desired. The opening for large books should be at the left-hand end so that the front page of the magazine will be in sight.

The data sheets of MACHINERY should be removed and bound separately since they are intended as a handbook for frequent consultation. A practical method of binding these sheets is shown in Fig. 2. The covers are made of heavy picture mat board, beveled at the joint, with a hinge of strong cloth on the inside, as shown in Fig. 3. Two adjustable studs hold the book together and permit new sheets to be added or old sheets to be re-arranged. These studs are in two pieces, one screwing snugly into the other and by their use a considerable range of thickness is permitted.



Figs. 2 and 3. Binder for Machinery's Data Sheets.

The usual stock advice on what to read and how to read it will be left unwritten. There can be no doubt as to the advantage to a workman of a course of reading along the lines of his daily work even at the expense of some of the sensational literature of the day.

Mr. Dooley says "Carnegie didn't learn to make steel billets reading 'When Knighthood was in Flower.'" The demand today is for practical men who are well posted in their work. "Who reads much soon begins to think." Employers are realizing that well-read men are the most valuable, since a workman's brain can do more work than both his hands. To aid their men in reading good literature, many establishments subscribe to the most desirable periodicals and place these where the men can have access to them. Fig. 4, for instance, shows the reading room of the Casino in the Fairbanks Scale factory, where the daily papers and most of the technical and miscellaneous magazines are always to be found. The appreciation of the men is shown by the well worn condition which the newest magazines soon reach.

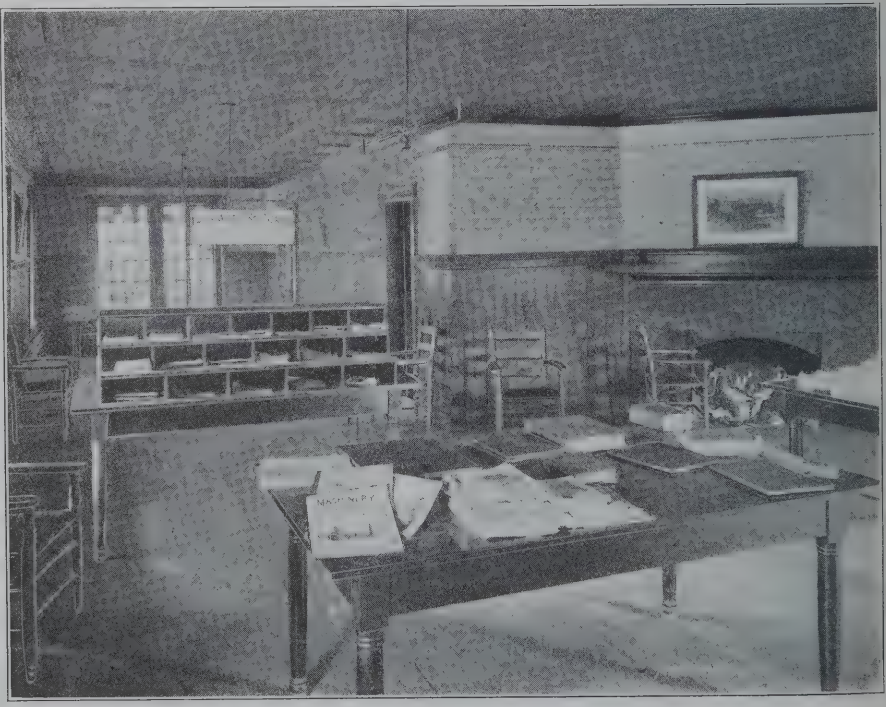
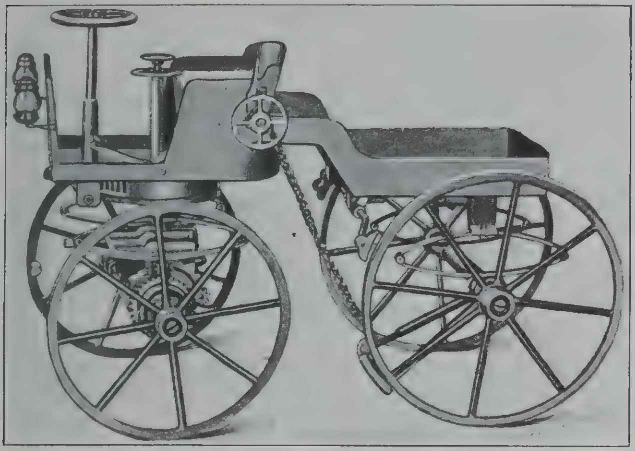


Fig. 4. Reading Room, Fairbanks Scale Factory, St. Johnsbury, Vt.

THE SELDEN PATENT.

THE CLAIMS OF THIS PATENT COVER PRACTICALLY EVERY GASOLINE MOTOR VEHICLE.

What will prove to be one of the most famous patent cases in history is that of the Selden patent, which has been the subject of extended litigation and on March 20th, last, was pronounced valid by the United States Circuit Court, Southern district of New York. This patent has broad, base claims covering every kind of an automobile fitted with a liquid hydro-carbon motor, and unless the latest ruling is reversed by the Supreme Court, which is very unlikely, as it is probably not within its jurisdiction, all manufacturers of gasoline motor carriages must pay a royalty to the Electric Vehicle Company, Hartford, Conn., the owners of the Selden patent.


Original Model of Selden Motor Carriage.

The remarkable thing about this patent is that, while it was granted on November 5, 1895, the application was filed in the patent office on May 8, 1879, and was kept alive during that period by the technicality of patent law which allows applications to be renewed year by year, provided an amendment is made when the new application is filed. The patent thus holds on the basis of the conditions existing at the time the application was filed, and is binding for seventeen years from the date of issue in 1895. It was on Thanksgiving of that year that the first automobile races of any account in this country took place in Chicago, under the auspices of the Chicago "Times-Herald" and it is from that time that automobilism may be said to date in America. The patentee, therefore, by his clever manipulation during the formative period of the industry, has managed to reserve his patent rights for a period of seventeen years of active automobile manufacturing, during which time the royalties will amount to millions of dollars; whereas, if he had pushed his claims at the outset, and secured a patent at once, it would have expired at the time when the industry began and would have been valueless.

Selden, the inventor, was a lawyer at Rochester, N. Y., during the seventies and spent his spare time experimenting with horseless carriages. After six years of hard work and the construction of five or six different engines, he produced a carriage that would work, and finally applied for a patent on the same, submitting a model, which is still in the patent office, a cut of which is shown herewith. In his application the inventor made many claims, one of the most important of which is the following:

"I claim—1. The combination with a road locomotive, provided with suitable running gear, including a propelling wheel and steering mechanism, of a liquid hydro-carbon gas engine of the compression type, comprising one or more power cylinders, a suitable liquid-fuel receptacle, a power shaft connected with and arranged to run faster than the propelling wheel, an intermediate clutch or disconnecting device and a suitable carriage body adapted to the conveyance of persons or goods, substantially as described."

The Electric Vehicle Co.'s predecessor, the Columbia and Electric Vehicle Co., secured from Mr. Selden on November 4, 1899, the exclusive rights to his automobile inventions, but only after about six months' negotiation, during which thousands of dollars were expended in investigating the validity of his patents, agents even being sent to Europe to find, if possible, some person who had anticipated the claims of Selden. The improbability of accomplishing this will be evident when it is remembered that the internal combustion engine did not come before the public to any extent until 1876, at which time Selden was at work on his automobile idea. After this investigation the company immediately commenced a suit against the then strongest outside automobile manufacturer, the Winton Motor Carriage Co., with the object of having the validity of the patent thoroughly proven. The Electric Vehicle Co. was soon assured of a thorough contest, as the principal outside infringing manufacturers organized a defensive association to support the Winton Co. With the news of the entering of the decree sustaining the patent also comes the announcement that all of the most important gasmobile manufacturers in the country have acquired from the Electric Vehicle Co. royalty licenses. Included among these licenses are the Winton Motor Carriage Co., the Haynes-Aperson Co., the Autocar Co., the Olds Motor Works, the Packard Motorcar Co., the Knox Automobile Co., the Peerless Motor Car Co., the J. M. Pierce Mfg. Co., the Searchmont Motor Co., Aperson Bros. Automobile Co., the Locomobile Co. of America, the International Motor Car Co., the Waltham Mfg. Co., the Pope-Robinson Co., Pan-American Motor Co., the H. H. Franklin Mfg. Co., and the United States Long Distance Automobile Co. These companies are representative of the western as well as the eastern industry and comprise all of the best established gasoline automobile makers in the country.

The defendants in the case assert that the Selden claims will eventually be broken, but in view of the action of these several companies it seems hardly probable that such will be the case. As long ago as 1896 the Commissioner of Patents, in his annual report published in the Official Gazette for May 12th, indorses the Selden patent as follows:

"Selden, in 1895, received a patent, November 5th, No. 549,160, which may be considered the pioneer invention in the application of the compression gas engine to road or horseless carriage use."

Such in brief are the main facts about this remarkable patent case which is to affect the whole automobile industry. It is now expected that all the reputable builders of gasoline automobiles will join the Association of Licensed Automobile Manufacturers, with a view to protecting themselves by compelling all outside competing firms to pay the Selden royalties as well as the members of the association. The expenses of such legal action as may be necessary to effect this will be borne by the association as a whole. Many valuable patents will be controlled by the association also. The articles of incorporation are said not to include anything pertaining to the regulation of prices, the object being simply to protect the various patents held by the members.

* * *

BRAZING CAST IRON BY THE PICH PROCESS.

At the regular monthly meeting of the A. S. M. E. in New York, April 7, the topic for discussion was furnished in a short paper by Wilfred Lewis on brazing cast iron by the Pich ferrofix process, which was read by the secretary, Prof. Hutton, as Mr. Lewis was unable to attend. Demonstrations of the process were given in which broken bars of cast iron were brazed, a portable Bunsen burner apparatus and firebrick muffle being used for the purpose. After the reading of the paper Mr. Alexander, of the American Brazing Co., gave an informal talk on the subject, in which he answered questions asked by the members.

He stated that the brazing process actually increases the strength of cast iron bars, if it is properly done, the increase of strength being from five to ten per cent. This refers to the metal adjacent to the joint; the joint itself is always stronger than any other part. The reason for the increase of strength is ascribed to the effect of the ferrofix on the structure of the cast iron by which the free carbon is burnt out by uniting with the ferrofix compound, which is a metallic (copper) oxide. It is owing to this action that it is possible to braze cast iron; the presence of carbon being the reason why cast iron cannot be brazed in the ordinary manner the same as wrought iron and brass. In fact, after the ferrofix paste has been applied and the carbon burnt out, the actual brazing process does not differ materially from ordinary brazing, spelter and a flux (borfix) being used. The action of the ferrofix is said to be quite penetrating, traces of its work having been detected two or three inches into the solid metal away from the joint, and even further. It is possible to "ferrofix" a small piece throughout.

Mr. Alexander also referred to a comparatively new development of the process that promises to be of great value to iron founders, and that is the repair of castings containing blowholes or other defects, by "ferrofixing" the walls of castings in the holes and pouring molten cast iron into them, which has also been "ferrofixed." His company have repaired several large defective castings at the Cramp shipyard in Philadelphia so perfectly that they passed Government inspection. The size of the holes so repaired did not exceed four or five inches across the largest diameter; what the possibilities are for larger defects is not yet known. To overcome the effect of shrinkage the piece to be repaired is heated as hot as possible and the molten metal is poured at a low heat. The "ferrofixing" of the holes is done by Bunsen burners, great care being taken to get the metal perfectly clean and free of scale, rust, etc. To "ferrofix" the molten metal a small amount, such as can be picked up between the thumb and fingers, suffices for a ten-pound ladle.

In the paper read reference was made to a practice now followed to some extent in Germany in relation to making large castings of complicated shape. Instead of casting such a piece whole they are made in four or five or more pieces and then brazed together, thus avoiding the danger of failure always attending the production of a large piece in one casting. To show the size of work that has been successfully handled a photograph of a large shear was shown which had been cracked vertically through the frame just back of the gap. This crack, which was nearly seven feet long, was repaired without moving the shear from its foundation.

* * *

POWER TRANSMISSION SYSTEM.

The W. F. and John Barnes Company, manufacturers of drilling machinery, have in use at their works a rope transmission system which is distinctly novel. One objection to rope transmission as ordinarily installed, is the splice joining the two ends of the rope. It usually requires the services of an experienced person to make it, considerable time is required for splicing, and unless the work is well done the splice will be larger than the body of the rope, causing undue wear and unsatisfactory running. The fact that the rope must be spliced has also made necessary the use of twisted rope of cotton or hemp, instead of braided rope, which is said to be considerably stronger and more durable, although we have not been able to find a record of tests to substantiate this.

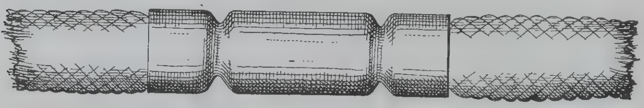


Fig. 1. Metallic Fastener for Ends of Rope.

In the Barnes system, braided rope is used, and the ends are joined by a metallic belt fastener, the invention of Mr. B. F. Barnes, who has patented the device. The fastener consists of a metallic ferrule, shown in Fig. 1 and in section in Fig. 2, with the two ends of the rope to be joined. The ferrule is of such a diameter that it will slip over the ends of the rope. In applying it, one end of the rope is inserted to about the center of the ferrule and fastened securely in place by forming an annular groove at one end of the ferrule, deep enough to indent both the ferrule and rope. This groove is made by a special hand tool, shaped like a pair of pliers, with one wide and one narrow jaw, both of which are curved as in a pair of gas pipe pliers. One of the jaws is narrow for grooving and the other is broad to back up and support the ferrule in the process. The next step is to drop a small quantity of melted wax into the open end of the ferrule and upon the end of the rope, and while the wax is still warm, the other end of the rope is inserted in the open end of the ferrule and forced against the wax. By twisting the rope somewhat and pressing it into the wax the latter becomes imbedded in the fibers and as it cools, forms a hard, solid lump. If necessary, the ferrule may be heated to keep the wax soft while this is done, and before the wax hardens, the other end of the ferrule is creased and the joint is complete.

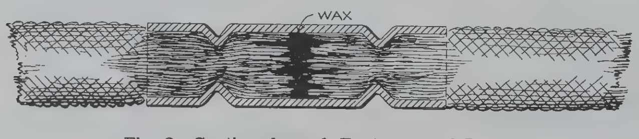


Fig. 2. Section through Fastener and Rope.

The surprising thing about the system in use by the Barnes company is the small diameter of the rope. The American or single-rope system of transmission is used in which a single rope passes back and forth between the grooves of the driving and driven sheaves, making as many lengths of rope as are necessary to carry the load, while the slack is taken up by means of an idler sheave and attached weight. The rope employed is the ordinary braided window cord about 5-16-inch in diameter or what is known as the Silver-Lake A brand, and this has been found satisfactory for transmitting power of any amount that has been required. The style of sheave used for the transmission is shown in Fig. 3. It consists of a wooden pulley, covered with leather glued and pegged securely to the face of the pulley, and grooved for the rope. From such data as is available it would appear that a single rope 5-16 inch in diameter would easily transmit one horse power at a speed of 1,000 feet per minute; or in other words would transmit as much power as a single leather belt one inch wide. One 16-rope drive is transmitting regularly 57 horse power at a speed of 3,225 feet per minute; another drive with 10 ropes is transmitting 27 horse power at a speed of 3,900 feet per minute. A severe test of the system is to be found in the application of the drive to the woodworking shop where a surfacing planer, saws, lathes, etc., are in operation. The writer saw the planer belt shifted on and off repeatedly and it could not be noticed that this affected the rope drive for this department to the slightest degree.

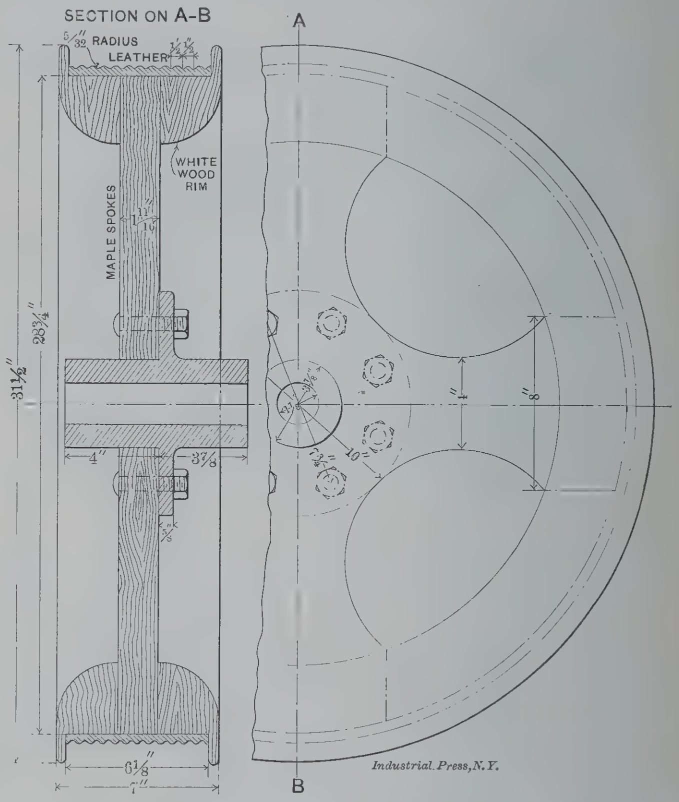


Fig. 3. Leather-covered Rope Sheave.

* * *

The compound gas engine in which a cylinder of larger dimensions receives the exhaust from two smaller cylinders, seems to be a practical success. Engines of this type are being made by Crossley Bros., Manchester, England, and we have recently seen an experimental engine of the same type in New York that is pronounced a success, being reliable in action and considerably more economical in consumption of gas than the simple type.

AN OUTLINE OF THE MANUFACTURE OF NITROGLYCERINE.

While killing time waiting for a train at Olean, N. Y., a few weeks ago the writer dropped into a machine shop near the Pennsylvania Railroad depot in which are manufactured supplies for the oil well business, including among other things, machinery for the manufacture of nitroglycerine. Mr. Luther, the proprietor, besides being a practical mechanic, has had experience in the manufacture of nitroglycerine, and he gave the writer a somewhat thrilling account of it. He insisted, however, that the danger was not greater than in many other hazardous occupations—provided the maker is not a careless man and that he never makes mistakes. If he *is* careless—well, the coroner will have a hard time to find the remains, and will have no difficulty in finding the cause.

The manufacture of nitroglycerine is a simple operation; in fact nitroglycerine is one of the simplest explosives to manufacture known. Mr. Luther said that it was small cause for wonder that anarchists and other evil-disposed persons use nitroglycerine for their destructive acts. In the first place, it is, of course, the most destructive for bulk and weight, and then it is so easily made from inexpensive materials. A few pints of nitric and sulphuric acids in about equal proportions, a small quantity of sweet oil of glycerine, a stone jar, a bucket of water and a wooden spoon complete an outfit with which a person of comparatively little skill can in twenty minutes make enough explosive to blow up a five-story block.

The commercial apparatus for manufacturing nitroglycerine consists essentially of a nitrator, a drowning tank, a power wash tank, and a lead-lined storage tank. These are arranged like the steps of a stair, the nitrator being at the top, beneath that the drowning tank filled with cold water, then the power wash tank filled with warm water, ending with the storage tank for the finished product. The nitrator consists of a circular iron drum setting in a square tank fitted with water connections so that a constant current of water can be circulated around the inner tank in which the nitric acid, sulphuric acid and glycerine are combined. The top is covered over, and through the center passes the shaft of a vertical paddle driven by hand or power. An opening in the top is fitted with a pane of window glass so that the interior can be seen. The sulphuric and nitric acids come to the nitroglycerine factories already mixed in iron tanks containing about 1,500 pounds each. With this amount of acid about 220 pounds of glycerine are mixed. During the mixing process the paddle constantly agitates the mass and the operator keeps close watch of a thermometer immersed in the tank while with one hand he regulates the flow of the glycerine into the tank by means of a valve. The chemical reaction causes heat and if the temperature reaches 115 degrees trouble is likely to come "mighty sudden." If there is a tendency for the temperature to go too high the glycerine is shut off, the effort being to keep it down to about 70 degrees, but sometimes the temperature continues to go up even when the glycerine is shut off and possibly the mass will catch fire and burn with a bluish flame. In this case the mass is drawn off into the drowning tank which is filled with cold water and then allowed to cool down.

When the action goes along smoothly the combined mass is drawn off into the drowning tank just the same after the reaction is complete, where it sinks to the bottom and cools. From the drowning tank it is drawn off into the power wash tank filled with warm water. Here the mass is agitated until the uncombined acids are washed out. No metallic surfaces are allowed to work together in the presence of nitroglycerine. Consequently no valves are used in the pipes; instead hose are used, the flow being shut off by hooking the discharge end up above the level of the tank being drawn off. The paddles of the agitators are made of iron, all parts of which are welded together. No riveted or bolted construction is allowable in any metallic working part, for the reason that the points spring open more or less when working and if any nitroglycerine gets "pinched" there is something doing right away.

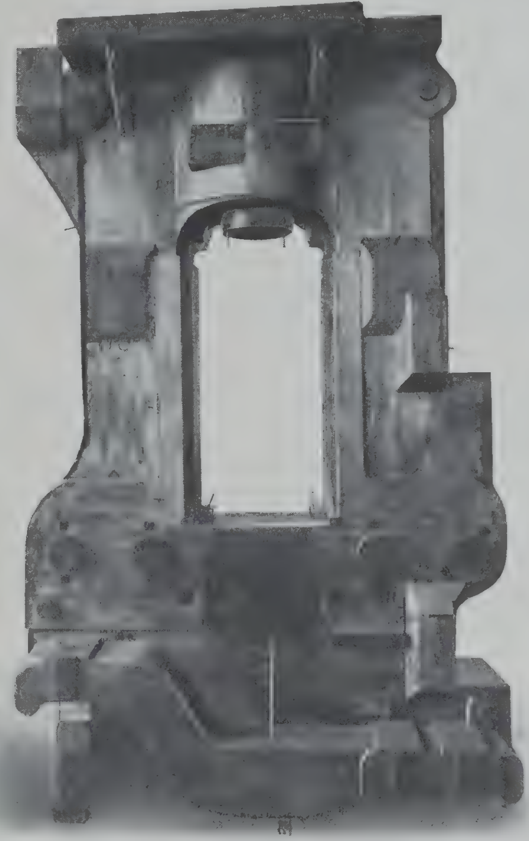
The nitroglycerine business is an exception to the general tendency toward consolidation. The danger of the business prohibits manufacture in large quantities at a time in one factory and the rigid rules of the railroads against transporting it make it necessary to manufacture it somewhere near the place it is to be used. Some secluded spot is chosen, usually on the side of a hill where a cave can be dug for storing it.

Dynamite is nitroglycerine mixed with some substance that absorbs it and reduces the danger of accidental explosion. Soda and wood fiber are largely used for this purpose.

* * *

PATTERN FOR SIXTY-FIVE TON HOUSING.

A somewhat interesting example of the heavy pattern work called for in the building of modern rolling mill machinery is that shown in the illustration. It is a pattern recently made at the works of Mackintosh, Hemphill & Co., Pittsburg, Pa., for the cast iron housings of a 32-inch slabbing mill which they are building for the Lackawanna Steel Co.'s new plant at Buffalo, N. Y. The mill has four of these massive cast iron housings, each weighing about 65 tons. A comparative idea of the size of the pattern and, of course, of the casting made from it, can be gained from the two-foot rule shown resting against the base.


Example of Large Pattern Work by Mackintosh, Hemphill & Co.

This slabbing mill, which is said to be the largest yet built in this country, is designed to handle ingots up to 30 inches thick and 54 inches wide. It gives one an idea of the massiveness of the rolling mill machinery now required for the manufacture of the larger commercial steel products.

* * *

The *Western Electrician* illustrates in a recent issue a miniature electric motor which was built by one Joel Ettinger in 1851 at York, Pa., and which is now in the possession of the York Historical Society. This motor, which is among the earliest produced by American inventors, operates on the principle of an armature, being alternately attracted to the poles of an electro-magnet and then released. The oscillating motion thus produced is converted into rotary motion by means of a small walking-beam and a crank. The source of energy was a galvanic battery. The model is in perfect order and although nothing ever came of it directly, it is of considerable interest now, in view of the great development of electrical machinery.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
66 WEST BROADWAY, NEW YORK CITY.
CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to The Industrial Press, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MAY, 1903.

NET CIRCULATION FOR APRIL, 1903,—26,247 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

The privilege conferred on railroads by which they can condemn private property when required for right of way, track extensions, or other purposes necessary to efficient operation, is sometimes a serious menace to manufacturing establishments so located as to be in the way of such extensions. Especially is this the case when a large group of buildings is planned and all arrangements have been made to concentrate a number of plants into one large one. To have a railroad company seize part of the land necessary for such a plant before the buildings had been erected, would undoubtedly entail greater damages to the private concern than any court would award them in condemnation proceedings. To head off an occurrence of this nature a large concern that is now building an extensive plant in New Jersey on ground likely to be wanted by the Pennsylvania Railroad, incorporated an industrial railway which is to be built to serve the various buildings of the plant. The articles of incorporation not only cover the rights to build on the ground level, but also on various other levels, thus effectually shutting off seizure of the property by another railroad. Not a bad scheme by any means—that is for the concern.

* * *

THE INVENTOR UNDER MODERN CONDITIONS.

The nineteenth century has been characterized as the age of invention and the twentieth century bids fair to be known as the age of combination. The query naturally arises as to what effect combination will have on invention—whether the inventive genius of the nineteenth century will continue and increase in the twentieth, or whether combination will stifle invention.

A contribution on the subject that has attracted much attention is an article by Mr. William Stanley upon "The Inventor and the Trust" in the *Springfield (Mass.) Republican.* Mr. Stanley shows how the trust sometimes swings its club over the head of the inventor and deals him a crushing blow. The trusts have patent bureaus with strong legal talent prepared to exhaust the resources of any competitor or individual inventor by extended litigation and legal procedures extending, perhaps, through many years. By this means control of many patents is secured while the honest inventor passes from view, sadder and poorer.

Sometimes, when a patent is issued the trust attorneys decide that their organization should own it and a low price is offered, along with the statement that one of their own inventors had worked out the same result some years before. Unless the inventor sells the patent then and there he may be subjected to coercion. First, notice may be served on him by the United States Patent Office that (although this patent was issued to him) an interference had been declared between his patent and a new application. Testimony is then taken as to dates of invention claimed by both parties. In all probability the real inventor proves priority, and the contending application is dismissed; but—and here the important part comes in—the trust lawyers are now in possession of the inventor's sworn dates of invention, back of which he cannot go. Another application signed by another applicant is put into interference with him. Again the dates of invention are given, and the inventor now realizes that he has a hard fight for his patent on his hands.

While admitting the truth of these statements, it is evident that abuses of the patent system are amenable to law and Mr. Stanley makes several suggestions for the control of patents and the methods of patent litigation that he thinks will work a change for the better. We would like also to remind the reader that the way of the inventor has always been hard and that on the average he has not obtained what was his due. This was the case at the beginning of the last century when many ideas were originated but could not be carried out because tools and facilities for manufacturing were lacking; it was so still later at a time when people of means had not become conversant with the possibilities of mechanical development and looked upon many practical schemes as visionary; and later still, the litigation, now carried on so successfully by large corporations, was conducted by individuals with quite as much disadvantage to the inventor as at present. For our part, we do not believe that the inventor has any harder row to hoe now than in the past.

On the contrary, there are many more channels for invention and more things to be improved than ever. There is the accumulated experience of years to take advantage of; and of more importance still, there never was a time when capital could be so easily raised to promote a good invention, provided the inventor had the business ability to bring his work into prominence. The main trouble with the inventor at all times has been that he has lacked this business ability. He has not been able to meet his opponents on equal ground. An early instance of this was the case of Oliver Evans, the brilliant Philadelphia engineer who failed to score the pronounced success of his contemporaries, Stevens and Fulton, because he was not a man of affairs and was not able to command the resources of the latter two. From that day to this scores of similar instances could be cited and while inventors may be and undoubtedly are now imposed upon by large corporations, these very corporations have made possible the development of certain patents which could not have been developed in any other way. If an inventor has not the ability, backing or influence to take advantage of these conditions now, we doubt very much whether he would have been able to achieve success under the old order of things.

* * *

While it may be quite generally understood that the building of steam boilers in the leading shops is one of the best examples of rapid constructive work of high grade, we think there are many who scarcely appreciate the rapidity with which the standard horizontal tubular is put together where such work is made a specialty. The writer was recently assured by the vice-president of one of the largest boiler making concerns in the United States that they were able to commence a boiler in the morning and have it completed, tested and loaded ready to ship on the evening of the succeeding day, and that they frequently built them complete in less than 48 hours. In connection he mentioned an amusing occurrence which bears out what we say in the opening sentence. A large steel concern in Western Pennsylvania gave his firm a rush order for a battery of horizontal tubular boilers. A force of men were concentrated on the order and a record made, the result being that the boilers were completed before the specified time. They were loaded and shipped, and arrived at the new works before the foundations were ready to receive them. The concern, thinking that it was impossible for the boilers to have been built to order in so short a time, accused the makers of palming off second-hand boilers on them, and it required considerable explanation to assure them that such was not the case. It may be mentioned that nearly all the product of the boiler concern is insured by the leading boiler insurance company of this country, which is a pretty good guarantee of its trustworthiness, so that rapid work does not by any means indicate poor work in the boiler business.

* * *

STEEL AS AN ABRASIVE.

A hindrance to the more extensive use of toolholders with inserted tools of self-hardening steel has been the troublesome job of cutting the steel bars into suitable lengths for use. It has been necessary either to heat the steel and nick it, or to break it off cold, leaving a ragged edge. The new cutting-off machine for this purpose recently brought out by the Armstrong Bros. Tool Co., which is described in another column, seems to make this operation much more convenient and draws attention to a shop process not commonly known or at least seldom utilized. In this machine the cutting is performed by a tool-steel disk rotating at high speed. The disk has no teeth, but wears itself through the steel bar without difficulty. The disk apparently partakes of the nature of an abrasive wheel, and the theory is advanced that the abrasive substance is made up of minute particles of the steel being cut which become imbedded in the edge of the disk and apparently give to the disk the cutting or wearing-away action that it has upon the bar of steel. This conclusion seems reasonable from the fact that the steel disk does not wear appreciably, indicating that its edge must be continually renewed from some source. It is also noticed that a new disk has very little effect on the bar at the start, but after it has run in contact with the bar for some time, it begins to cut into it more rapidly, apparently because the steel particles have become imbedded in it.

A machine, similar in principle to the Armstrong cutting-off machine, has been in use at the Pennsylvania shops at Sunbury, Pa., for several years, but for an entirely different purpose. This machine has a spindle on one end of which is a disk of tank steel running at a peripheral speed of 9,000 feet a minute, used for cutting off locomotive flues. On the other end is a steel cupped wheel made by flanging an ordinary steel disk. This wheel is used like an emery or any abrasive wheel for squaring off the ends of the flues after cutting, by simply forcing the end of the flue against its surface until the tube becomes square. It takes about 30 seconds to cut off a two-inch flue and the disk itself does not wear perceptibly. One disk is said to have been in use for seven years. The flue becomes red hot at the point where the cutting is in progress and it is a question whether this softening and possibly melting action may not account for the performance of the disk rather than the theory of imbedded particles in the surface. It apparently sets up a condition akin to that encountered by a hot saw in cutting off rails in a steel mill. And if this is the case, who can explain the action of the cupped wheel in squaring the ends of the flues? There is an opportunity here for a new line of investigation and possibly for the development of a new abrasive process of great value in shop operations.

* * *

THE STATUS OF ALCOHOL MOTORS.

Space is given this month to a review of the progress abroad in the use of alcohol for industrial purposes, especially in internal combustion engines. Engineers in Germany, France and Russia have given much attention to the matter and as there are no restrictions corresponding to our internal revenue tax on spirits there is every promise of extensive development of alcohol motors.

Compared with gasoline, alcohol is at a disadvantage from the commercial standpoint, though in respect to efficiency, considered simply as a heat motor, it has the advantage. Strong arguments in favor of alcohol for power purposes are that its production can never be restricted sufficiently to come under the control of a trust and that it is not a dangerous explosive like gasoline. It can be produced easily from a variety of vegetable products, its manufacture from the potato receiving a great deal of attention abroad at the present time. It is customary to denaturalize alcohol that is to be employed for industrial purposes by adding some distasteful element to prevent its use as a beverage by those who are habitually thirsty. It is said that in countries where its manufacture for the arts is encouraged by the removal of the internal tax on this denaturalized product, there has actually been less intoxication. This is ascribed to the disposition of the dealers to sell the commercial alcohol on which there is a good profit, rather than pay a heavy license fee for the privilege of selling the pure alcohol for beverages on which the profit is no greater.

Speaking in a general way, alcohol contains only about two-fifths as many heat units per pound as gasoline and thus at the start is at a disadvantage, without regard to the cost. Tests quoted in our contributed article, however, show the efficiency of an alcohol motor to be from 25 to 30 per cent., while it is known that the efficiency of a gasoline motor ranges from 15 to 20 per cent. In the absence of further details, we are able to account for this only by the fact that a mixture of alcohol vapor and air can be compressed in the engine cylinder previous to ignition to a much higher pressure than can a mixture of gasoline vapor and air without becoming hot enough to produce premature explosion. In the tests referred to, the compression in the alcohol motors was carried to 10 or 15 atmospheres, and it is well known that the efficiency of a gas engine depends largely upon the extent of compression.

The number of gallons of alcohol consumed per horse power hour would be considerably more than the quantity of gasoline that a gasoline engine would require per horse power hour. In the tests quoted in our contribution the consumption of alcohol is about one pound per horse power hour when the engine is loaded economically, which is equivalent to one-sixth or one-seventh of a gallon; while a gasoline engine should run on one-tenth gallon under similar conditions. This, coupled with its higher price, is the main argument against the value of alcohol as an engine fuel at the present state of the art. Experiments show, however, that a carburized alcohol, 50 per cent. alcohol and 50 per cent. of some petroleum product, gives results rather better than gasoline alone, and the mixture can be used in existing gasoline engines without extensive changes.

We are of the opinion that the removal of the tax on alcohol for the arts in this country would lead to important developments in internal combustion engines and that probably for every dollar thus sacrificed the impetus that cheap alcohol would give to chemistry and the industrial arts would net very handsome returns.

* * *

Prof. R. H. Thurston in a paper, "Heat Exchanges Within the Steam Engine," read before the American Association for the Advancement of Science, December, 1902, referred to experiments that prove the steam consumption of an engine is practically unaffected whether compression takes place, or not. The mean of twelve tests made by Prof. Dwelshauvers-Dery on his experimental engine at Liege, Belgium, at 0.47 compression, gave the consumption at 24.526 pounds per horse power; without compression the mean of thirteen subsequent experiments showed the consumption to be 24.532 pounds per horse power. The steam remaining in the cylinder of a simple engine at the end of the exhaust period is dry and sometimes even slightly superheated; the walls of the cylinder are also dry. When compression begins the temperature of the steam rises and continues to rise as compression proceeds until its temperature equals that of the cylinder walls. During this period the pressure increases until the temperature of the steam exceeds that of the cylinder walls when it begins to yield up heat to the latter, producing the curious hook in the indicator diagram which has often been erroneously attributed to leakage. Prof. Thurston concludes that in the light of recent experiments it is not necessary in ordinary construction to assume the presence of water in the cylinder to account for certain phenomena; and that there is no real conflict between theoretical and "experimental" thermodynamics of the steam engine.

ALCOHOL FOR INDUSTRIAL PURPOSES.

THE RESULTS ACCOMPLISHED IN THE USE OF ALCOHOL FOR HEAT, LIGHT AND POWER.

In one of his consular reports, Consul Mason, of Berlin, dwells upon the potato as a source of wealth in Germany, in which he considers the potato, not only as a food, but as the basis of many technical products of value, notably of alcohol for use in the arts. Everywhere there is an indication of a larger use of alcohol for lighting and heating purposes and for power. At the Exposition of 1903 there were exhibits by fifty firms of apparatus for the manufacture and use of alcohol for technical and industrial purposes, each firm displaying from two to twenty machines or pieces of apparatus.

The German government have done a great deal to stimulate the use of alcohol for practical purposes and the Russian government have employed alcohol boat motors of 300 horse power in the navy with highly successful results. Among the exhibits at the exposition was a 50 horse power Russian marine engine, of the internal combustion type, using alcohol, and directly connected to a dynamo. Its efficiency will be inferred from the tests, which showed its alcohol consumption to vary from 0.45 to 0.5 liter (.47 to .53 qts.) per horse power hour. At 650 revolutions per minute it developed about 61 horse power and ran with such steadiness that the difference between running light and with full load was only 3 per cent. Like many other alcohol motors, this is started and warmed up with gasoline, and a lever changes the supply from gasoline to alcohol as soon as full speed has been attained. The ignition is by electric spark, and the moment of ignition can be adjusted to occur at the most advantageous part of the stroke, thus securing maximum economy.

The department devoted to lighting apparatus at the exposition included a varied display of lamps, chandeliers, and street and corridor lights, in which alcohol vapor is burned like gas in a hooded flame covered by a Welsbach mantle. Under such conditions alcohol vapor burns with an incandescent flame which rivals the arc light in brilliance and requires to be shaded to adapt it to the endurance of the human eye.

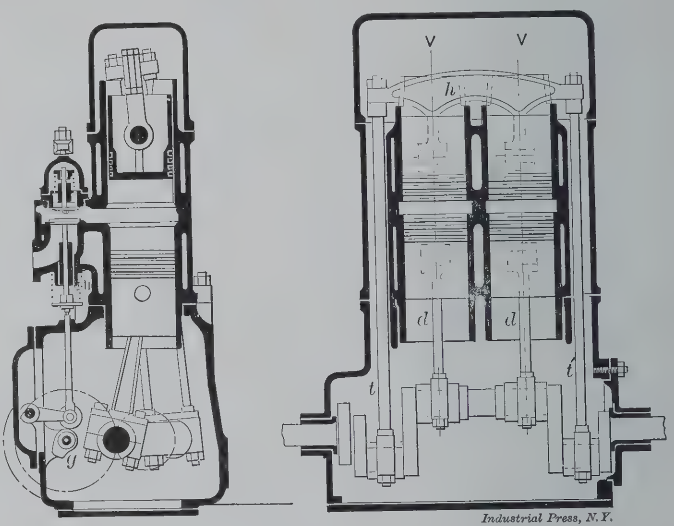
Similarly attractive and interesting was the large display of alcohol heating stoves, which, for warming corridors, sleeping rooms, and certain other locations, are highly esteemed. They are made of japanned iron plate in decorative forms, with concave copper reflectors, are readily portable, and, when provided with chimney connections for the escape of the gases of combustion, furnish a clean, odorless, and convenient heating apparatus.

Cooking stoves of all sizes, from the complete range, with baking and roasting ovens, broiler, etc., to the simple tea and coffee lamp, were displayed this year in endless variety. This entire department—the use of alcohol for household purposes—is ably and efficiently managed by the Central Association for Alcohol Distribution, which keeps a large depot in Berlin and other German cities, where everything that can use denaturized alcohol is kept on sale. As another example of the efficiency of this organization may be cited its system of alcohol distribution to rural districts. Since the inception of the movement steam has in many instances been displaced by alcohol motors for threshing, grinding, fuel cutting, and other agricultural purposes, it being claimed that the alcohol motors have the advantages of immediate readiness of operation, no coal or water to be provided, no fireman needed, freedom from smells or danger of fire, and, finally, greater economy of maintenance. But in order to promote the substitution of spirit motors for steam and horse power, it was necessary to make alcohol cheap and easy to obtain by farmers in districts where no raw spirit is made. To meet this requirement, the Central Association undertakes to deliver free at any railroad station in Germany denaturized alcohol of 90 per cent. purity, in quantities of 180 to 200 liters, for 15, 16½, and 17½ pfennigs per liter (approximately 15, 16, and 17 cents per gallon), according to the material with which it is denaturized. As the consumption of a modern alcohol motor for farming purposes is about 0.5 liter (costing about 2 cents) per horse power hour, it will be apparent that in this country at least benzine and petroleum have met a serious competitor as fuel for motor purposes. The Hamburg-American Steamship Company has in service a harbor-inspection launch which, with a 23-horse power spirit engine, makes a speed of 10 knots, and preparations are being made to greatly extend the use of such motors in the launches and ships' boats of the German navy.

Internal Combustion Alcohol Motors.*

The use of alcohol as a motor, while having been tried by Brayton in Philadelphia as far back as 1876 or so, received but little impulse until 1894-5, when Germany took it up to encourage its agricultural and distilling industries. In France Lockert in 1896 made experiments, as did Arachequesne, Pétréano and others. The French Department of Agriculture, in direct contrast to that in Germany, discouraged the attempts as Utopian. The Paris newspaper "Vélo" in 1899 inaugurated a contest of alcohol-driven automobiles and bicycles; from Paris to Chantilly. Four automobiles appeared, only one started. The weather was bad. The trip of 137 kilometers (85 miles) was made by an Armand & Briest machine with two persons, in 8 hours 8 minutes; that is, 17 kilometers (or 10.6 miles) per hour. The consumption of pure spirit was 37 liters (= 9.87 gallons).

In 1899 Gutman put on the market a carburetted half-and-half alcohol which was tested in a benzine motor; the results were gratifying. The Exhibition of 1900 showed the Körting pure alcohol motor and the Martha carburetter on a Dietrich carriage. The "Criterion of Alcohol" in 1900 was "a bolt from the blue." There were 40 entries for the Paris and Rouen competition. Of these, four used pure alcohol; one, the new carburetted spirit of Leprêtre.



Industrial Press, N.Y.

Fig. 1. Brillie Motor. Fig. 2.

At present, one of the best examples of a carburetted alcohol motor is the Brillie, using "Stellane." Figs. 1 and 2 show an axial and a cross section, of the Brillie motor and Fig 3 is a diagrammatic representation of the carburetter and valve arrangement. There are two vertical cylinders, *VV*, open at their ends. In each there are two pistons, the lower of which drive by means of the connecting rods *dd*, and the upper ones through the rods *tt*, the connection being through the crosshead *h* in the upper part of the sketch. The middle crank is at an angle of 180 degrees from the outside cranks.

In each cylinder the pistons move in opposite directions; the explosive being produced between them. The motor is of the "four cycle" type and the cycles in each alternate with those in the other, so as to give one impulse per rotation. In order to get the best possible counterbalance the throw of the middle crank is longer than that of the outside cranks, thus compensating the difference in mass by difference in piston speed.

The distribution is effected by vertical valves, shown in Fig. 3, the upper one of which is the intake, working automatically, and the lower one the exhaust, operated by a cam on the cam shaft *g*. A distributing wheel *G* is employed for introducing the alcohol. It is in the form of a conical plug having pockets around its periphery, and as the distributor revolves these pockets become filled with the liquid from the reservoir and are successfully brought before the orifice at the left where the liquid is forced out by a blast of air in pipe *P* and vaporized in intake pipe *M*.

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* Contributed by Robert Grimshaw.

The rotation of the distributor plug is effected by a ratchet mechanism under the control of the governor. There are as many teeth in the ratchet as there are pockets in the distributor, so that every time the ratchet is advanced one tooth a pocket containing a charge of alcohol is brought opposite the atomizer. The governor which controls the rotation of the distributor is of the inertia type, working on the hit-and-miss principle. A weight is oscillated back and forth by an eccentric motion and as the connection between the weight and the shaft which gives it its motion is a flexible one (either by an intervening spring or by frictional contact) the inertia of the weight will cause it to travel ahead or lag behind its shaft, according as the engine speed retards or accelerates. This movement of the weight causes a dog which reciprocates with the eccentric to be thrown into or out of contact with a tappet attached to a lever which operates the ratchet mechanism. The inertia effect of the governor is modified by a spring, the tension of which can be adjusted by hand through the lever indicated at the lower right-hand corner of the engraving, and the speed of the engine varied from 300 to 1,400 turns a minute. It will be noted that the intake pipe *M* is prolonged downward and to the right for the admission of air through a valve at *L*, and to insure that the proper quantity is taken in to produce the combustion mixture the valve *L* is placed under the control of the hand lever mentioned above, so that when the speed of the engine is changed the volume of air is changed to correspond with the quantity of alcohol used under the new conditions.

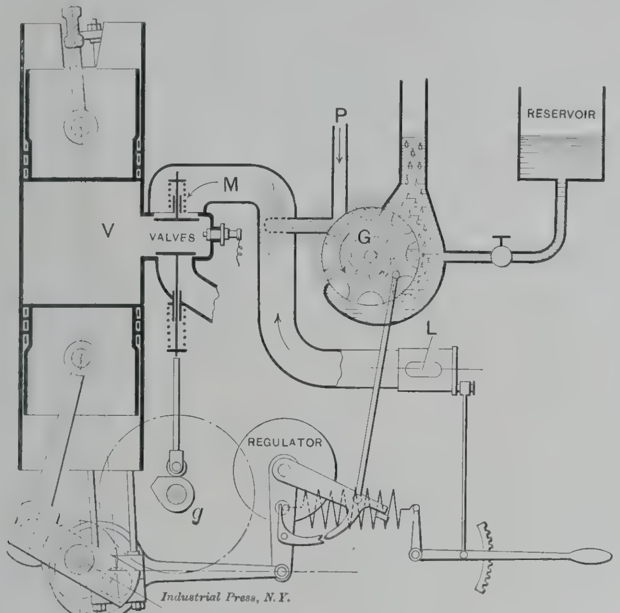

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Fig. 3. Valve and Vaporizing Arrangement.

The explosion of the alcohol and air mixture is less sudden than that of benzine, and the temperature of combustion is lower and better sustained. The same is true of carburetted alcohol as compared with benzine.

Chauveau's tests go to show that up to a speed of 1,000 turns per minute, carburetted alcohol gives out greater power than benzine; this difference, however, diminishes at greater speeds.

The products of combustion of alcohol have a less disagreeable odor than those of benzine. Being less volatile, it is hence less dangerous; and there is less waste in storage. This is of special importance in hot countries. Further, there are districts where benzine is difficult to procure because the steamship lines object to carrying it except in full cargoes and at excessive rates. Alcohol has the advantage of being procurable in agricultural districts by distillations from grain, potatoes, waste beet-pulp, etc., and can be manufactured with comparatively inexpensive apparatus.

At a meeting of the Hanover branch of the German Engineers' Society there was read a report by Prof. E. Meyer on alcohol motors. Tests with three Marienfelder motors gave as follows:

ALCOHOL PER HORSE POWER HOUR.

Motor I.	Lbs av.
Full load, 23.36 H. P.	0.898
¾ load	0.968
½ load	1.115
¼ load	1.588

Compression 10 to 12 atmospheres; maximum cylinder pressure 28 atmospheres.

Motor II.	Lbs av.
Full load	0.935
¾ load	1.025
½ load	1.223
¼ load	1.879

Compression 12 to 13 atmospheres; maximum cylinder pressure 30 atmospheres.

Motor III.	Lbs. av.
Full load	0.867
¾ load	0.959
½ load	1.115
¼ load	0.582

Compression 13 to 14.5 atmospheres; maximum cylinder pressure 32 atmospheres.

This figures up, if we consider full load and take the caloric value of alcohol as 5,500 calories, to an efficiency of 28.7 per cent.

* * *

PROPORTIONS OF GEARS.

C. F. BLAKE.

In the February and March, 1902, issues of MACHINERY the writer gave such information as would enable a designer to determine the size of any gear, the form and strength of the teeth, and to lay out the tooth form. When designing a gear, however, there are other things of importance to be considered which were not touched in the above articles. These are the proportions of the rim, arms and hub. The number of arms in any gear is determined arbitrarily, and may be from three to eight, or even more, while many pinions too small to allow of arms between the rim and hub, must be made with solid webs.

Let R = the pitch radius of the gear in inches,

n = the number of arms,

W = the load at the pitch line = $s\ p\ f\ y$,[*]

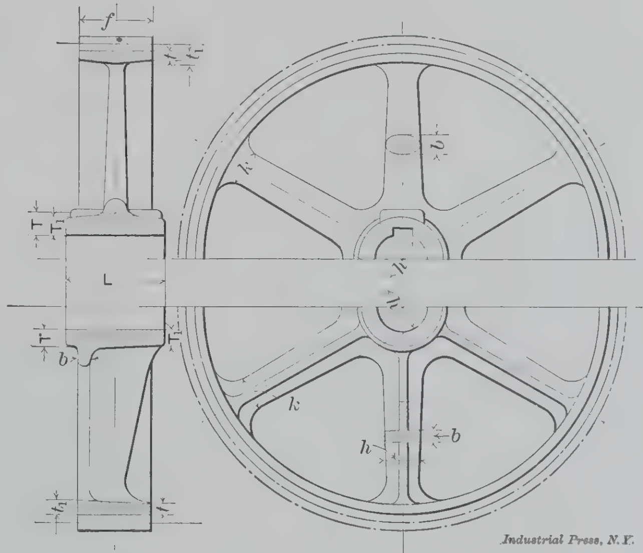

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Fig. 1.

then the bending moment on each arm is approximately,

$$M = \frac{W\,R}{n} = \frac{s\,p\,f\,y\,R}{n}$$

The arms of gears take various forms, the best being the elliptical and T-sections, as shown in Fig. 1. The elliptical section lends itself well to the design of spur gears, while the T-section is desirable for bevel gears and wormwheels, where there is considerable thrust parallel to the shaft against which the gear must be stiffened, which is well accomplished by the rib of the T-section. In order that a gear shall mold well and produce a casting free from inherent strains, the metal must be well and evenly distributed, which may be accomplished by making $b = 0.6\ p$, where b is the thickness of the arm, as in Fig. 1, and p is the pitch of the gear. The proportions of the arm may then be as follows for,

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[*] From Mr. Wilfred Lewis' formula for the strength of gear teeth, used in the previous articles mentioned.

In this formula s = the allowable fiber stress, p = the circular pitch, f = the face, and y = a variable from the table given on the next page, where it is repeated for convenience.

Elliptical Sections.

Z = section factor.

$$Z = \frac{\pi}{32}\, b\, h^2 = .058\, p\, h^2$$

$$M = S\, Z \text{ or } \frac{s\, p\, f\, y\, R}{n} = .058\, p\, h^2\, s$$

$$h^2 = \frac{f\, y\, R}{.058\, n}$$

$$A\ s\ R = \frac{n\, p}{2\, \pi} = 16\, n\, p$$

we have

$$h^2 = \frac{.16\, n\, p\, f\, y}{.058\, n} = 2.7\, f\, y\, p$$

and

$$h = \sqrt{2.7\, f\, y\, p}$$

T-Sections.

Z = section factor.

$$Z = \frac{b\, h^2}{6} = \frac{.6\, p\, h^2}{6} = .1\, p\, h^2$$

$$M = S\, Z \text{ or } \frac{s\, p\, f\, y\, R}{n} = .1\, p\, h^2\, s$$

$$h^2 = \frac{f\, y\, R}{.1\, n}$$

$$A\ s\ R = \frac{n\, p}{2\, \pi} = .16\, n\, p$$

we have

$$h^2 = \frac{.16\, f\, y\, p\, n}{.1\, n} = .016\, f\, y\, p$$

and

$$h = \sqrt{.016\, f\, y\, p}$$

VALUES OF y.

No. of Teeth	Involute Teeth.	Radial Flanks.
12	.067	.052
13	.070	.053
14	.072	.054
15	.075	.055
16	.077	.056
17	.080	.057
18	.083	.058
19	.087	.059
20	.090	.060
21	.092	.061
23	.094	.062
25	.097	.063
27	.100	.064
30	.102	.065
34	.104	.066
38	.107	.067
43	.110	.068
50	.112	.069
60	.114	.070
75	.116	.071
100	.118	.072
150	.120	.073
300	.122	.074
rack	.124	.075

The dimension h is made to taper from the hub to the rim, and in elliptical sections the dimension b is also made to taper. This taper may be 7-16 inch to one foot for h, and 5-16 inch to one foot for b, the taper measured on the whole dimension.

The usual rim sections used with the above-mentioned arm sections are shown in Fig. 1, in which the dimensions are

$t = 0.47\ p$.

$t_1 = 0.56\ p$.

For bevel gears the thickness of the rim may be as shown in Fig. 2.

$t = 0.56\ p$.

Low and Bevis in their work on machine design give the following formula for the thickness of hubs, when made proportional to the diameter of a shaft which would have the same strength as the gear.

$$T = \sqrt[3]{\frac{f\, p\, R}{3}}$$

where f = the face of the gear,
p = the circular pitch,
R = the pitch radius.

The length of the hub is sometimes made the same as the face of the gear, but more often it is 1.5 times the diameter of the shaft. The taper of the hub may be ⅛ inch to one foot, and a boss should be placed over the keyway to make up for the metal taken out in cutting the keyway. An important method of increasing the strength of any gear is by means of shrouds or annular rings cast on the ends of the teeth as shown in Fig. 3. The strengthening effect of a shroud depends upon the face of the gear in inverse ratio, as while in all cases the shear between the shroud and the teeth is the same, it forms a greater ratio to the cantilever resistance of the tooth as the face becomes narrower. In practice, pinions are more often shrouded than larger gears as, owing to the form of their teeth, they require shrouds to make them equal in strength to the meshing gear. As the teeth of shrouded gears cannot be finished or ground, plenty of clearance must be left between the shroud and the teeth of the meshing gear, as shown, in combination with different methods of shrouding, in Fig. 3.

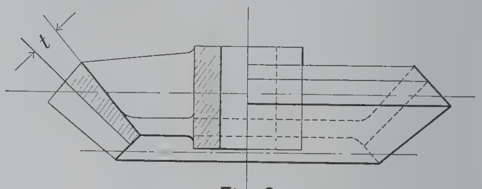


Fig. 2

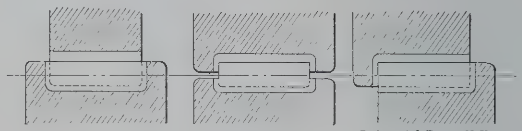


Fig. 3

* * *

THIRTY-SIX INCH TRIPLE-GEARED LATHE.

The triple-geared lathe, shown in Figs. 1 and 2, has just been brought out by the Bradford Machine Tool Co., Cincinnati, Ohio. In this tool are combined the leading features of the regular line of lathes manufactured by this company together with a number of new ones that have been added to increase the rigidity and wearing qualities and the ease of operation. The cone has five steps for 5¼-inch belt, the back gear ratio is 6.25 to 1, and the triple gear 40.61 to 1, thus giving 15 speeds, which are arranged in geometrical progression.

In the front of the bed, under the headstock (Fig. 2) can be seen a nest of six gears, the lower three of which are drivers while the upper ones are keyed to the leadscrew. By means of a slip key controlled by a pin with a hexagon head, either set of gears may be brought into action, thereby giving three changes of feed or three different threads without changing the end gears. These changes, together with the usual change gears, give a wide range of threads. It is often found necessary to cut threads of very coarse pitch and outside of the range usually had on screw cutting lathes. For this purpose there has been incorporated into this lathe means where-

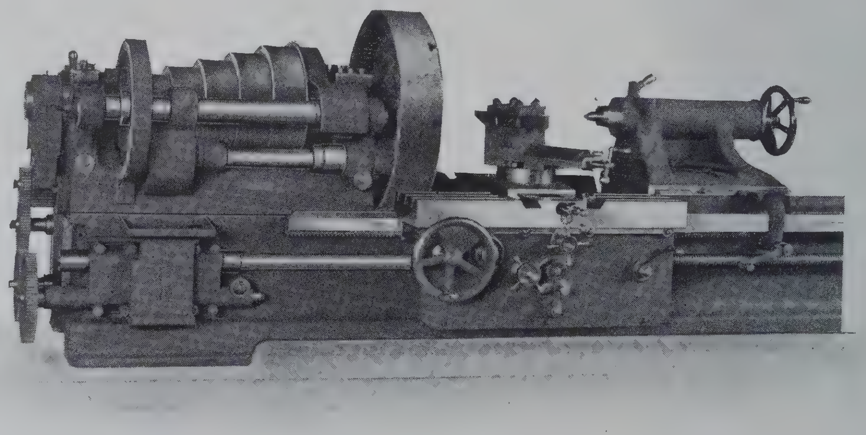


Fig. 1. Bradford 36-inch Triple-geared Lathe.

by this may be accomplished without any complications or compounding of gears. In the rear end of the headstock is a sliding bearing supporting a short shaft that has gears on either end. As they are shown, the inner gear is in mesh with a small gear on the cone and from the cone, motion is communicated directly to the screw. In this case the ratio is 8 to 1, when driven from the spindle, so that if the lathe is geared nominally to cut 1-inch pitch it would with this arrangement cut 8-inch pitch.

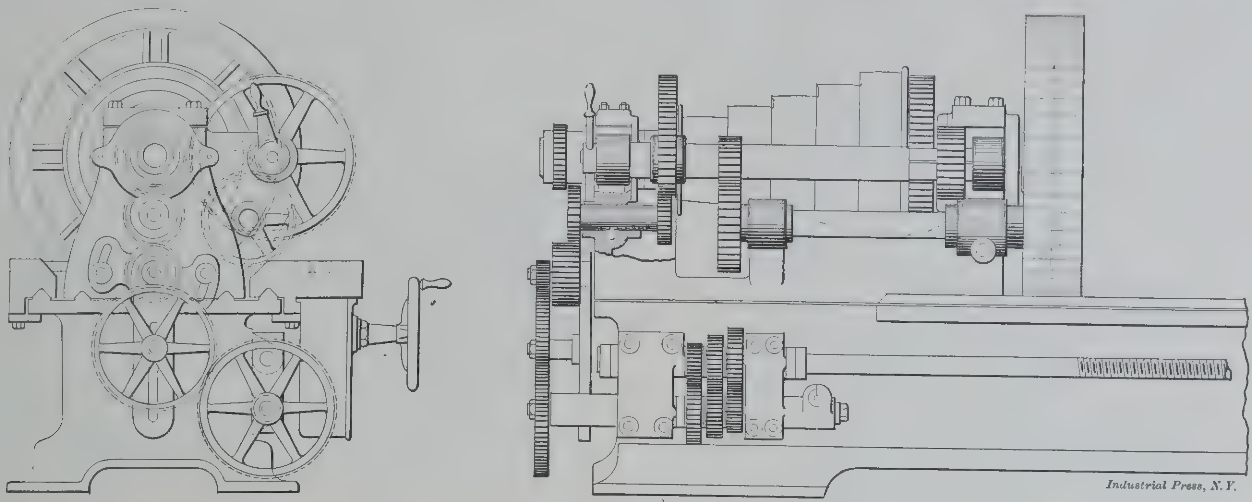

Industrial Press, N.Y.

Fig. 2. Change Gearing of Bradford 36-inch Triple-geared Lathe.

The carriage is fitted with a compound rest which has power feed in all directions and the top slide has a motion of 12 inches. The apron is provided with a reverse and a simple non-interfering device which renders it impossible to engage more than one feed at a time. The leadscrew is cut with an Acme standard thread and splined its entire length, the threads being used only for screw cutting. The tailstock spindle has long movement and bears in the tailhead its full length. The tailstock as a whole is easily moved along the shears by a rack and pinion.

* * *

ORE HANDLING.

The wonders accomplished in the mining and handling of iron ore in the United States by the application of modern machinery are outlined in a special report to the British Government made by the Acting British Consul at Chicago, Mr. T. Erskine, a copy of which has been received by the Treasury Bureau of Statistics. The report is entitled "Report on the Iron Ore Industry of the United States," but gives especial attention to the modern methods of mining and handling ore, by which hand labor has been greatly reduced. In mining ore in certain parts of the Lake Superior region he says that the top covering of ground rock is scraped off over the whole property before mining begins. Railroad tracks are then laid direct to the ore bed, and the ore is loosened by blasting. Steam shovels are then brought into use and they load the ore directly upon the cars, one of these machines having loaded 170,000 tons in 26 days, or at the rate of over 6,500 tons per day. These loading machines, which daily handle more than 6,000 tons, are each operated by 5 men, and the labor cost for mining and loading averages but about 16c. per ton, and in the case of one mine, which dug and loaded 293,651 tons in 174 days, the labor cost was only 4c. per ton.

In the transfer of ore from mine to vessel on the Lakes the absence of hand labor is also noticeable. The ore trains are run onto long docks extending high above the water and having large pockets or compartments into which the ore is discharged from the cars through an opening in the bottom of the car, from which the ore runs by gravity into the pockets beneath the tracks. From these pockets the ore is loaded into the vessel, also by gravity, and passed down long chutes into the hold of the vessel so that no hand labor is required in transferring the ore from the cars to the vessel. The ore pockets or compartments, which form a part of the dock, hold about 160 tons each, and number from 90 to 384, according to the length of the dock.

In unloading the ore from the vessels the saving of labor through the use of machinery is even more notable and important in its economies and results. A series of steel bridges, so adjusted as to be easily moved along the docks, is supplied with a hinged arm, which can be lowered to the hatch of the vessel. Along this arm and across the bridge runs a trolley train to which are attached automatic "grabs" similar to a double scoop, which are so constructed that the grab or scoop digs downward into the ore as it closes. The grab or scoop holds about 5 tons of ore and is described as a "digging machine," as when it begins to draw together it digs into the ore and does not depend on its weight to get hold of the ore. There are 15 unloading machines in a battery, and the grabs run down the long arms which are lowered over each of the 14 hatches that are in the deck of most lake vessels carrying ore. These hatches run nearly the whole way across the decks. The grabs can thus remove over half the cargo without any assistance and the remaining half is brought directly under the hatch by use of a scraper also operated by similar machinery and managed by a man in the hold through the use of long cords. This scraper brings the ore from between the hatches so that it can be raised by the grab. These grabs are controlled by the engineer who can drop them at any point over the hold that he may wish and after it seizes its load of ore it is raised at full speed, carried rapidly along the trolley to such given point as desirable, where the ore is deposited into railroad trucks or stock piles, or in some cases into concrete troughs through which it slides to the furnaces, where it is to be transferred into pig iron. This grab, which thus lifts five tons of ore from the vessel carrying it to such point as is desired within a limited space, has a hoisting speed of 100 feet a minute, and can run along the bridge at the rate of 1,000 feet a minute. The operator travels with the grab and can unload it at any given point desired. The bridges to which these arms, with their grabs, are attached can be swung in any direction, so that ore, limestone, or coke can be deposited or picked up anywhere in the yard. They are worked by electricity. Twenty-six men will now perform, under this system, the work for which 300 were required under the old system.

* * *

Wrought iron and steel increase in tensile strength with increase of temperature up to 500 degrees F. Cast iron becomes perceptibly weaker at 200 degrees and at about 1,000 degrees it only has about one-third its normal strength at ordinary temperatures.

* * *

To find the heating surface required in feedwater heaters, a quick rule is to divide the known pounds of feedwater used per hour by 100 for copper, 90 for brass and 60 for iron pipe. The quotient will represent the required number of square feet of heating surface. This method of calculation applies particularly to the coil type of heater in which the circulation of feedwater is generally more rapid than in heaters of other types. This rule is based on authority of the Whitlock Coil Pipe Co.

THE COOLEY EPICYCLOIDAL STEAM ENGINE.

A NEW TYPE OF ROTARY ENGINE AND THE PRINCIPLE OF ITS CONSTRUCTION.

Without doubt no other type of steam engine has ever received the time and attention of hundreds of inventors that has been devoted to the attempt to produce a satisfactory rotary engine, and the number of patents that have been granted for different designs of this style of engine is exceedingly large. Upon trial, however, all, or nearly all, of these engines have failed to show any economy of steam production at all approaching that attained by the regular reciprocating engine. Many of the designs that seemed to possess promising possibilities have been so complicated as to be subject to excessive wearing of the operating parts so that in a short time they have become useless.

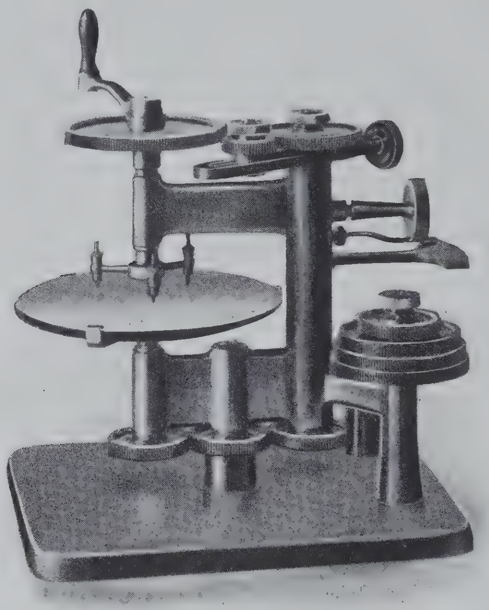
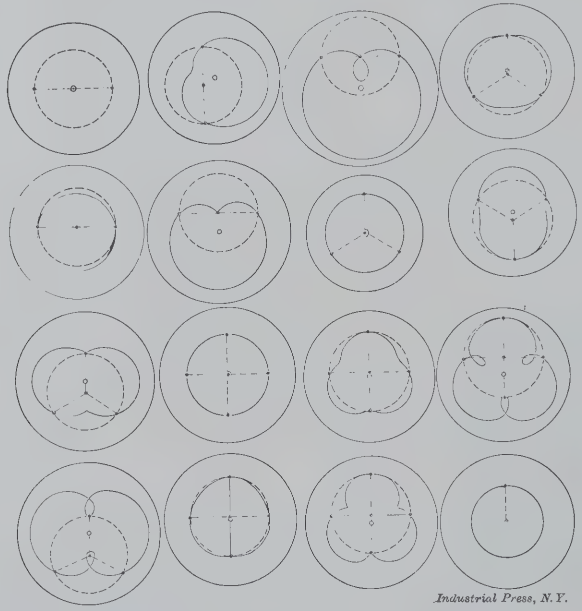


Fig. 1. Cycloidograph for Illustrating Principle of the Epicycloidal Engine.



Industrial Press, N. Y.

Fig. 2. Some of the Curves Generated with the Cycloidograph.

We illustrate herewith a type of rotary engine of unquestionably simple construction which constant trial for a period of over two years has proved to possess good wearing qualities, while reliable tests that have been made show that it is at least equal in the economical use of steam to the best reciprocating engines of the same capacities. This engine is the invention of Mr. J. F. Cooley and the patents are owned by the Cooley Epicycloidal Engine Co., who have established a thoroughly equipped laboratory at Allston, Mass., where the original engines have been built and the tests conducted. It is the plan of this company to establish branch shops in various parts of the country where the engines will be built for the different purposes for which they are adapted, while the Allston plant will be used for experimental purposes and for the construction of new types as they are designed.

This engine consists of a horizontal cylinder having at each end a bearing for the main shaft which runs directly through it, but whose center is eccentric with the center of the cylinder. Firmly fixed to the main shaft and revolving with it is a bilobed piston which, however, does not come in contact with the walls of the cylinder at any point in its revolution. The intervening space between the piston and cylinder is filled by a ring, called a spacer, which has a series of longitudinal slots and bars that form ports and valves for the admission and control of the steam. Both piston and spacer revolve in the same direction but at different rates of speed.

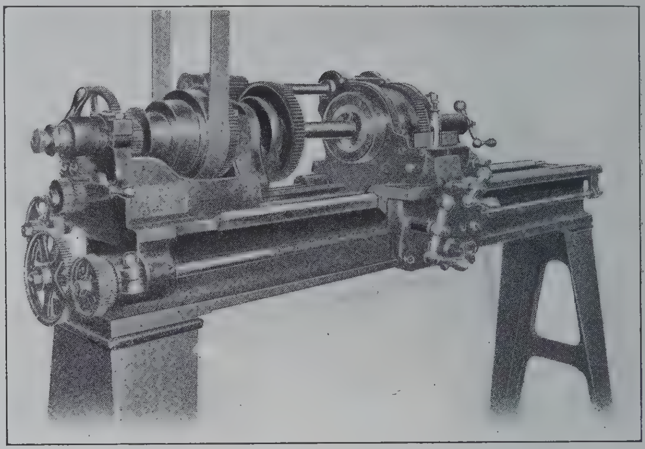


Fig. 3. Cycloidal Lathe Boring Trilobed Spacer of Epicycloidal Engine.

To illustrate the principle upon which the invention is based, the cycloidograph, which is shown in Fig. 1, was designed. This consists of a number of points which are arranged so as to revolve about a plane which also rotates, in the same direction, but at a different rate of speed. The revolving points are supplied with markers and are turned by means of a crank shown at the top of the instrument. By varying the relative position of the centers about which the markers and the plane revolve, and also the relative speeds of rotation, any figure may be described upon the plane, including circles, triangles, nephroid forms, etc. Now if a piece of metal be substituted for the plane and instead of the markers some form of cutting tool is used, it will be possible to cut from the metal a hole of any desired form. Again, if the cutters were stationed at the proper points on a revolving annulus rotated at the same rate of speed as the plane, and a piece of metal substituted for the markers the metal could be turned to any required form. These principles are employed in the construction of the epicycloidal lathes which were built for the purpose of turning the pistons and boring the spacers which are used in the engine.

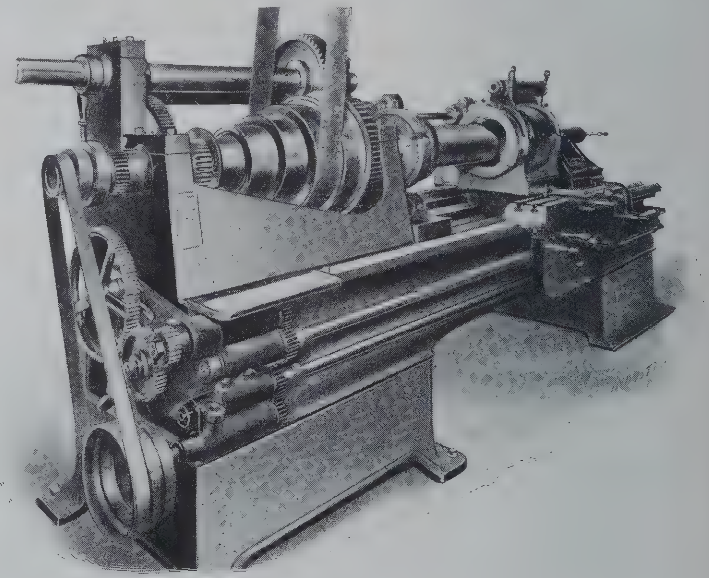


Fig. 4. Cycloidal Lathe Turning Bilobed Piston for Epicycloidal Engine.

Fig. 3 shows the lathe boring one of the spacers. The tool is held in a boring bar which is driven from the lathe spindle and rotates concentric with the centers of the lathe. The spacer which is being bored also rotates but at a different rate of speed and eccentric with the centers of the lathe. By making proper adjustments of the position of the centers and of the relative speeds of rotation, the tool will bore in the spacer a trilobed hole suitable to run with the bilobed piston which is shown in the process of being turned in Fig. 4. In this case the work is revolved on the lathe centers while the cutters, of which three are used, are revolved about a different center and at a different rate of speed. This action produces the bilobed piston which runs with the trilobed spacer after the form of a two-toothed pinion running in a three-toothed internal gear and the relative speeds are three revolutions of the piston to two of the spacer.

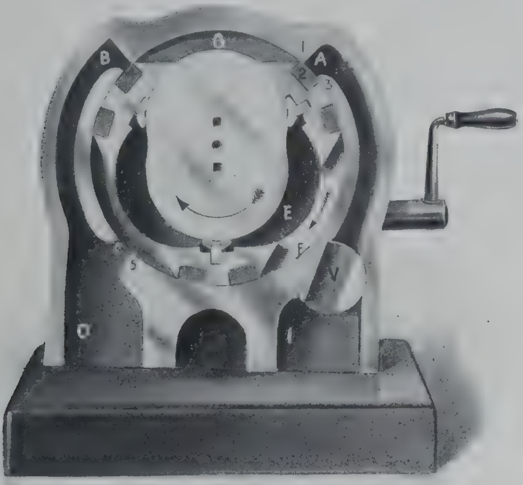


Fig. 5. Working Model of Epicycloidal Engine.

The action of the running parts of the engine and the method by which they are adapted to produce rotary motion are clearly shown in the model, Fig. 5. In this section *I* is the steam pipe and *O* the exhaust. Steam ordinarily enters at *A* and passes out through the exhaust port *C*. Both piston and spacer revolve in the direction indicated by the arrows and at relative speeds of three to two. In the position shown the engine is at its "dead point" and to start it in motion the valve *V* is rotated so as to allow steam to enter at the port *F*. As soon as the engine is started, however, this is returned to the position shown and all steam enters through the port *A*. Suppose now that the engine has started in motion so as to admit steam at the point 1 port *A*, into the chamber *G* which corresponds to the clearance space. As the motion continues, steam flows into the cylinder until the point 4 has passed the point 3, at which time cut-off occurs. As the piston and the spacer continue their rotation the intervening space between them gradually increases as shown at *E* and in this space expansion takes place. This continues until the point 2 has reached point 5 on the port *C*, when release occurs. Port *B* is an additional exhaust port which prevents any back pressure that might be caused by incomplete exhaustion through the port *C*. With this construction the horse power increases directly with the speed and approximately as the pressure of the steam used. There are no reciprocating parts and the speed can be varied at will from that of the slow speed reciprocating engine up to that of the high speed steam turbine. Governing is accomplished wholly by throttling, the point of cut-off remaining constant at all speeds.

TEST ON 10 H. P. ENGINE, MARCH 4, 1903.
Engine coupled to Dynamo.

Time.	Tank Weights.	Difference.	Boiler Pressure.	Vacuum in Condenser	Vacuum in Engine	Pressure at Engine.	Revolutions.	Volts.	Amperes
5 — 06	491.5	..	174	12.0	1.0	130	980	100.1	69.0
— 16	557.0	65.5	172	19.5	7.0	130	975	99.9	69.0
— 26	631.0	74.0	169	19.8	7.5	132	980	99.9	68.0
— 36	707.0	76.0	169	23.8	11.8	126	981	99.0	68.0
— 46	804.0	97.0	162	14.5	4.5	129	986	99.0	67.2
5 — 56	859.0	55.0	167	18.2	9.0	125	968	99.0	67.2
6 — 06	938.0	79.0	173	21.0	11.0	124	974	100.0	67.2
— 16	1014.0	76.0	172	22.1	11.0	122	976	100.0	67.1 67.1
— 26	1091.0	77.0	170	22.8	11.0	122	985	99.5 99.5	66.6 66.6
6 — 36	1166 0	75.0	168	23.0	11.0	119	...	99.0 99.0	66.0 66.0
Total...	......	674.5	1696	196.7	84.8	1259	8805	1193.9	875.0
Average	......	74.9	169.6	19.7	8.5	125.9	978.3	99.5	67.3

H. P. input to dynamo = 10.5 about 3% large.
Steam per H. P. hour = 42.83 lbs.

TEST ON 70 H. P. ENGINE, MARCH 14, 1903.
Barometer = 30.00 ins. Room Temperature = 80° F.

Time.	Tank Weights.	Difference.	Boiler Pressure.	Vacuum in Condenser	Vacuum at Engine.	Pressure at Engine.	Counter Reading.	R. P. M.
3 — 12	521	..	126	22.6	18.6	90	3 — 14	....
— 17	586	65	159	20.0	17.5	88	207,950	....
— 22	659	73	133	19.2	16.8	90	....	702
— 27	721	62	165	19.5	17.2	87	....	....
— 32	787	66	140	19.6	17.0	90	3 — 34	....
— 37	852	65	159	19.4	17.0	90	221,990	....
— 42	920	68	154	20.0	17.2	93	....	696.5
— 47	986	66	150	19 2	16.9	90	....	....
— 52	1052	66	172	20.8	18.1	90	3 — 54	....
— 57	1121	69	163	21.0	18.5	91	235,920	....
4 — 02	1188	67	155	20.8	18.0	90	....	698.5
— 07	1254	66	165	20.9	18.2	90	4 — 14	....
— 12	1320	66	...		18.3	90	249,890	....
Total or Average	799	799	154	20.3	17.6	89.9	....	699

H. P. output of engine = 25.6.
Steam per H. P. hour = 31 2 lbs.

As an example of the comparative size of these engines, a 10 horse power engine, running at a speed of 2,000 revolutions, measures but 14 inches long, is 6½ inches high, 5 inches thick and weighs only 45 pounds. Fig. 6 shows a 10 horse power engine direct connected to a 4-pole, 6-kilowatt generator running at a speed of 950 revolutions per minute. In this case it has the appearance of a good-sized outboard bearing. The accompanying tables show the results of a series of tests that were performed by Professor E. F. Miller, of the Massachusetts Institute of Technology. The engines so far tested have been neither compounded nor jacketed, and it is anticipated that when the jacketed compound engines are tested, very much better economy will be attained.

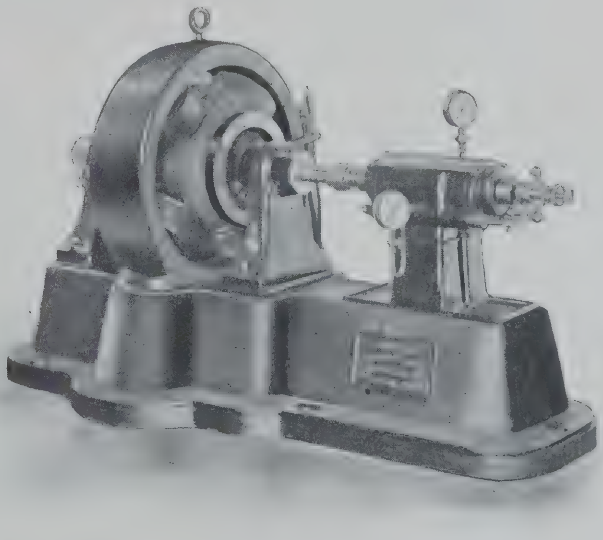


Fig. 6. Ten H. P. Epicycloidal Engine Direct-connected to 6-KW. Generator.

The engines are also built of the reversing type and owing to their extreme compactness are well fitted for marine and automobile work. One of these engines, running a propeller immersed in a tank of water, is often instantly reversed from full speed ahead to full speed astern without injury to the engine.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

At the annual meeting of the stockholders of the Pennsylvania Railroad Company held recently, when they voted to increase the capital stock from $250,000,000 to $400,000,000 Vice-President J. P. Green said that during the past two years the company has purchased an average of one locomotive a day and a total of 40,000 freight cars.

The city of Chicago is following the lead of Cleveland, St. Louis, Washington and other cities in the matter of smoke suppression, a question that has been agitated by the *Chicago Times-Herald* for a long time, apparently with good results. The city council has passed a smoke ordinance which puts the work of smoke inspection and boiler inspection in one department. All plans for steam plants must be examined and approved of before a permit for the erection of the buildings can be issued by the building department.

A French patent has been taken out by the De Dion-Bouton firm on a self-ignition device for internal combustion motors. A small cylinder is fastened to the side of the working cylinder with a port connecting the two. The piston of the small cylinder reciprocates at one-half the rate of that of the larger one, that is for two strokes of the main piston the auxiliary piston makes one stroke. An explosive mixture is drawn into the small cylinder on its down stroke, and this is compressed to such a degree on the up stroke that it spontaneously ignites and fires the charge in the working cylinder, the flame communicating by the port referred to.

Because of the notable achievements in utilizing the water power from the glaciers in the Alps between France and Switzerland a "white coal" convention was recently held at Grenoble, France, which was attended by over 500 prominent engineers. At Epirre, Savoie, a fall of 1935 feet is utilized; at Chapareillan, 25 miles from Grenoble, another fall of 2,040 feet has been utilized; Grenoble will soon be lighted by water power; and many other industries too numerous even to mention are now deriving their power from the mountain streams fed by the snow fields and glaciers of the Alpine mountain system. Of course what has made all this so recently possible, is long distance electrical transmission.

The first annual report of the National Bureau of Standards has been issued and reviews the work incident to organizing the departments and announces the plans for the future. Two buildings have been planned, one of which, the mechanical laboratory, is now under construction. It will include a boiler room, engine and dynamo room, a refrigerating and liquid air plant, storage battery room, rooms for heating and ventilating apparatus, and instrument shop, wood carving department, and a room for conducting electrical tests requiring heavy currents. The second building will be for a physical laboratory and contain apparatus that must be removed from the vibration and magnetism of machinery. Plans have been developed for carrying on several lines of work in the near future, such as standardizing lengths up to 10 feet, measurements of volume, electrical resistances, etc. In thermometry, preparations are being made to test temperature measuring instruments extending over a range from minus 140 degrees to 2,700 degrees F.

The distance between Wilkesbarre and Hazelton, Pa., is a matter of about 50 miles by either the Pennsylvania Railroad or the Lehigh Valley Railroad. A new electric third-rail line has been built between these two points which is only a little more than one-half as long, its length being 26 miles. This road is notable not only because of its permanent construction—stone bridges, deep rock cuts, heavy fills, tunnel through solid rock 2,600 feet long, 95-pound rails and avoidance of all grade crossings—but for the adoption of a hooded third-rail which, of course, prevents accidents to the workmen, but it was primarily adopted to prevent interference from winter storms. The third-rail is supported on the end of every fifth tie, which is made longer than the other four, and over the rail is placed a pine plank 2 x 6 inches, supported every 8 feet by oak posts, both the rail and the plank being supported on insulators. The third-rails are 60 feet long and weigh 80 pounds to the yard. The severe storms of last winter proved the efficiency of the protection, as otherwise it would scarcely have been possible to run the cars with any regularity at some of the worst periods.

The problem of towing canal boats by power has been receiving attention in Germany and experiments upon several types of towing machines are in progress. The main trouble experienced in towing by means of a steam or electric car running on rails along the tow-path comes from derailing whenever there is a sudden jerk upon the tow line, owing to the impossibility of keeping a uniform tension in the line. To overcome this an electric towing car has been designed by Messrs. Ganz & Co. The car is relatively light and has two pairs of wheels which are set at a convergent angle, so that both pairs run on the same rail, the balance of the machine being maintained by a pair of trail wheels running along the adjacent roadway. Almost the entire weight, however, is borne by the inclined wheels on a single rail, and the arrangement is such that the heavier the resistance load created by the boat, the tighter the grip of the wheels upon the rail.

It is proposed to equip a new canal 23 miles in length, south of Berlin, with this or some other system of electric towing. For an annual traffic of 1,500,000 tons 53 locomotives will be required, each capable of towing one boat of 600 tons or two boats of 200 tons.

The American Institute of Electrical Engineers have taken an important step, in line with the progressive management which has characterized this society, by the creation of a "student" grade.

This does not correspond to the "Junior" grade of the Civil and Mechanical Societies, but is intended for students at the technical schools or elsewhere. The sole requirement of applicants for such student membership is that they shall be "regularly pursuing electrical studies." Such men on suitable indorsement, may on payment of $3 per annum become students of the institute, and as such will receive the regular announcements and monthly "Transactions," and may attend any meetings of the Institute except business meetings. They may also purchase the semi-annual bound volumes of "Transactions" at $3.50 per volume. The continuance of such student membership is limited to not more than three years in any case. In connection with the local meetings of the Institute now held at fourteen prominent engineering schools, it will doubtless serve to make the Society known to a large number of young engineers and a considerable proportion of these will be apt to apply for membership in later years.

While public interest in the possibilities of electric automobiles has centered in the Edison battery, it must not be forgotten that marked improvements have been made in others, all of which are leading to a certain increase in popularity of electric vehicles. The *Western Electrician* reports a new alkaline storage battery exhibited at the Chicago automobile show that attracted a good deal of attention. The exhibit consisted of 28 cells, each weighing slightly less than six pounds and is said to have a capacity of 100 ampere-hours on a closed circuit of 1.4 volts per cell. These were connected to a light runabout mounted on a speedometer and a switchboard, the whole being arranged to demonstrate the possibilities of the new battery. The runabout, on a test made during the exhibition, required 30 amperes to drive it a speed of 20 miles an hour, and the battery was able to deliver this amount of current for three hours continuously. Each cell is hermetically sealed, and therefore it becomes unnecessary to standardize the specific gravity of the solution, and the spilling of the acid or electrolyte is prevented. The efficiency of the battery compares favorably with lead cells, and it is particularly attractive to the operator of an electric vehicle because he can give practically full charge to his batteries in an hour or two and discharge them at such a rate as conditions may require, without any danger to any part of the batteries. The cost of this cell is stated to be slightly above that of the lead cell.

At the sixth annual general meeting of the Marconi Wireless Telegraph Co., held March 31, in London, the chairman gave a short running account of the progress of the company during the year and said that the past eighteen months had been a period of the greatest activity, during which substantial progress had been made in the development of the system and the establishment of new stations. In referring to the attitude of various countries he stated that the Italian government had given them the heartiest support. In this connection Mr. Marconi stated that the Italian government had authorized him to construct a large station in Italy for the purpose of communicating with America; also that they had agreed to use no other wireless system of telegraphy for commercial purposes during the next fourteen years. In regard to the existing cable companies and their enmity he said that ever since 1897, when he first succeeded in communicating from England to France without wires, the cable companies had not ceased to regard his efforts as a menace to their interests and to endeavor by ridicule, misrepresentation and other means to discourage his progress. Regarding the statements that have been so widely circulated that interference between adjacent stations would surely prove an insurmountable bar to commercial work, he quoted from the report of Prof. Fleming, who has made an exhaustive investigation of the subject in the Marconi station at Poldhu. In Prof. Fleming's opinion the problem of interference has been satisfactorily solved and the statements to the contrary are not based on fact. The signals sent from Poldhu did not interfere in the slightest with the local wireless system for signaling to ships.

The many railroad accidents during the past year in the United States have led to an investigation by our consular officers of the methods employed by European railways to avoid disasters. Among the reports received at the State Department is one from Consul-General Mason, at Berlin, in which he tells of a new device which is being tested by some of the German railroads.

A light T-rail is laid between the rails, and midway under the engine is hung an electrical apparatus connected with a contact shoe which slides along the third rail. Wires connect with a telephone and an electric alarm bell in the cab, also with a red incandescent lamp which is lighted by the same impulse that rings the alarm bell. The device sets the electric brakes simultaneously with the alarm. The apparatus is so adjusted that the engineer can at any minute by touching a lever satisfy himself that it is working.

Numerous tests have been conducted. In one instance an engine drawing a special train at full speed received a danger signal and came to a full stop. The engineer then asked by telephone the cause of the signal and received from the keeper of a grade crossing, half a mile in front, word that a wagon had broken down in crossing the track and obstructed the line. After ten minutes' wait the engineer received word by telephone that the obstruction had been cleared away and resumed his trip.

Bearing on this subject is a recent report of the Illinois Railroad Commission, giving some statistics of derailments at interlocking grade crossings of railways in the State of Illinois for the past year, from which it appears that while, out of a total of 197 derailments only 7 were due to defects in the interlocking system, and 27 to defective track or rolling stock, no less than 138 derailments were due to trains running against the signals. In view of these statistics the Commissioners recommend the use of an automatic stop, acting directly upon the engine.

APPLICATION OF REVERSING ELECTRIC MOTORS TO PLANERS.

Mechanical World, April 10, 1903, p. 178.

The writer, Harold C. Gunson, refers to the fact that in the usual application of electric motors to planing machines, the motor is employed to drive the countershaft, or the driving pulleys are placed directly on the motor shaft and the reversing of the table accomplished by the usual mechanical means. This method of driving a planing machine has several disadvantages, chief among which is the very heavy current taken on reversing. This is sometimes overcome by means of a heavy flywheel on the motor shaft; but unsatisfactorily. The wear and tear of the belts and the tappet motion are also considerable, not to speak of the noise produced.

He then mentions the advantages of obtaining the reversal of the table by reversing the direction of the motor itself, saying there is no reason why a well-made motor should not be able to withstand a reversal every few seconds continuously, if the current in the armature when slowing down and getting up speed again is not allowed to exceed, say, double the full-load current. The motor—which should be shunt-wound—may be connected by means of a belt to the driving shaft of the planing machine, or it may be arranged to drive directly through the gearing. In the former case the motor is protected from overload by the slipping of the belt, and there will be less shock to the gears. This arrangement is therefore preferable, although it adds to the weight of the rapidly-revolving parts. The reversal is effected by a reversing switch actuated by the rocking shaft, in conjunction with a device for switching in resistances while the motor is slowing down to zero and getting up speed again, which is controlled by the current in the armature circuit.

In slowing down, the motor acts as a generator, the fields being constantly excited from the mains, and the current produced is passed through properly-regulated resistances which do not allow it to exceed some predetermined amount, until the armature comes to rest. Then the current is switched on in the opposite direction, and the amount through the armature regulated in the same way until it attains full speed. This piece of mechanism is the subject of a patent, and works exceedingly well. Quick return is obtained by weakening the field on the return stroke, a ratio of 3 to 1 being obtained with some motors. A separate starting switch is provided, and a field regulator for giving various cutting speeds to suit the different classes of metal operated upon.

This arrangement works smoothly and silently, and the driving bracket can be much reduced in size, as there is nothing on it but one pulley and the gearing. There is also much less wear and tear on the tumbler and other parts working in connection with it, which has practically nothing to do but operate the feed mechanism. It is, of course, advisable to reduce the kinetic energy of the moving parts which require reversing in direction, especially those that move the most rapidly. These are the armature and the pulleys. Therefore a slow-speed motor is the best for this purpose. The pulleys should not be of the high-velocity narrow-belt type, which is necessary when the belt has to be moved rapidly from one pulley to another. They should be reduced in diameter and increased in width so as to transmit the power required with as low a peripheral speed as possible. There is no difficulty, when the motor is running on the return stroke and the table moving at, say, 60 feet per minute, in bringing it to rest in as short a space as is necessary by increasing the field to its maximum strength while slowing down, thus obtaining a very powerful torque without an excessive current through the armature.

With regard to the use of induction motors, it will be more difficult to apply them to work of this kind, but with a little experimenting the three-phase motor may be found suitable. The direction of rotation of the field will have to be reversed while the motor is going at full speed, and resistances inserted in the rotor circuit in order to obtain sufficient torque, which must be gradually cut out as it slows down and gets up speed again, by an arrangement controlled by the current in the rotor circuit, in a manner similar to the direct-current motor. The quick return can be economically obtained by reducing the number of poles by means of a switch. The different cutting speeds requiring small variations in the speed of the motor may be obtained by resistances in the stator or rotor circuits, at the expense, however, of its efficiency.

APPARATUS FOR INSPECTING THE INTERIOR OF BOILER TUBES.

Le Genie Civil.

The specifications for boiler tubes usually require that the inside and outside surfaces shall be smooth and free from pitting and other defects and yet there is no attempt at inside inspection.

An instrument designed by M. J. Vinsonneau and made by Secretan, of Paris, makes such an inspection both possible and rapid. It consists, as shown in Figs. 1 and 2, of a tube *A* formed of several sections screwed together or telescoping into each other and painted white on the inside. An incandescent lamp *B*, with its reflecting mirror embracing it, illumines a section *m m*, of the interior of the tube. The image of this superficial section *m m*, as reflected in the mirror *D* is sent back along the tube to the mirror *D′*. The tube *A* is fastened at *a′* to a chamber *F*, which is fitted with an adjustable magnifying glass *G*. The mirror *D* is adjustable by means of the screw *E*.

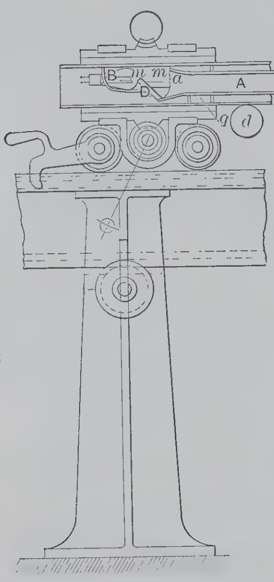
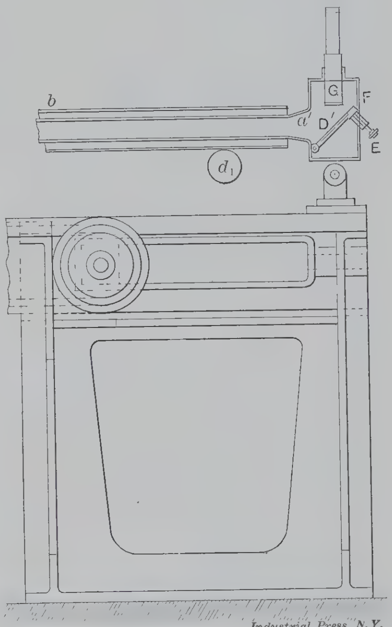


Fig. 1.



Industrial Press, N. Y.

Fig. 2.

The glass *G* and the mirror *D* may be done away with, but this arrangement is not the best adapted for an acceptance examination, though it is used for doing the work when tubes are in position in the boiler. During inspection the tube is firmly clamped in position and is run over the examining tube by means of gearing, either operated or controlled by the inspector, and the fastening arrangements are such that a tube can be rapidly and easily removed and replaced.—G. L. F.

USE OF SUPERHEATED STEAM IN STATIONARY PLANTS.

Zeischrift des Vereines Deutscher Ingenieure.

M. Hunger presents a paper relative to the modifications that must be made in boilers and engines when superheated steam is to be used.

The author calls attention to the fact that he was one of the promoters of the use of superheated steam in Germany, and recalls the numerous trials, the first of which were unsuccessful, that were made at the Gritzner Works at Durlack. The lack of success at the beginning was due to the necessity of changing the boilers and machines used. In the boilers it was necessary to increase the dimensions of the shell and do away with the vertical headers which were fragile and of low thermal efficiency. Superheaters should be made of tubular elements which can be put out of service when necessary. The steam engines should be fitted with cylinders especially constructed for the use of superheated steam, and the various details such as stuffing boxes and the like should have a different design from those ordinarily used. Mr. Hunger shows how these necessary modifications have been made and executed along lines that have seemed most favorable. He describes a number of boilers and engines of recent construction and shows how the steam consumption in each has been improved by the use of superheated steam. G. L. F.

LARGE ARMORED CONCRETE CHIMNEY.

Engineering News, April 2, 1903, p. 308.

A Ransome armored concrete chimney 180 feet in height, 15 feet in diameter at the top, and having a flue 11 feet in diameter, has recently been built at Los Angeles, California, for the new power house of the Pacific Electric Railway Co., which has a network of suburban electric roads centering in that city.

The chimney was built under the Ransome system, with a thorough reinforcement of square, cold-twisted steel bars, both vertically and horizontally in each shell. The horizontal reinforcement consists of rings of ¼-inch steel twisted bars, placed at intervals averaging 18 inches in the inner shell and 24 inches in the outer. Vertical bars of ¾-inch square steel, twisted, were placed 1 foot apart in the lower third of the stack above the flues, 2 feet apart in the middle section, and 4 feet apart in the top section of the outer shell. In the inner shell ¼-inch bars were used, spaced about 3 feet apart in the circumference of the work.

The original design of the chimney contemplated a straight shaft, 15 feet in diameter, throughout, from the base up. Subsequent alterations in the plans of the boiler house, changing the relative positions of boilers and chimney necessitated the provision of the two flue openings on opposite sides instead of one. The extra opening thus provided would have materially reduced the sectional area of the chimney at this point, and it was deemed necessary to increase the size to 18 feet for a height of 45 feet above the base. Above that point the chimney was built circular in form 15 feet in diameter. This change in diameter and form made it necessary to build a special mold for the lower section, which was rendered more difficult by the square projections of the flue openings, extending from the foundation up.

The mold was clamped together, or loosened when it was to be raised, by turnbuckles. During the time that this base section was being built the mold for the exterior of the circular part had to be pushed up ahead of the work, and supported on the scaffold by which the interior mold was raised, and from which all of the work was done. This obviated the necessity of building the 15-foot mold around the scaffolding 45 feet up in the air. This interior scaffold was kept ahead of the work all the time, and the exterior molds, when loosened, were raised 10 feet at a time by the suspending screw-rods, and hand wheels, from which they were hung to the head scaffold. The inner mold and cores were raised 5 feet at each setting, and concrete to the height of 5 feet was placed each day.

The entire construction was carried on from the interior, and all material was hoisted up the shaft by an electric hoist. All the scaffolding was built inside, and consisted of four 4 inch by 6 inch timbers for uprights, with 2 inch by 10 inch horizontal braces bolted thereto every 5 feet and 1 x 6-inch cross braces. The head, or top, scaffold was formed of 6x14-inch timbers to which the hoisting rods were attached. To obviate the labor of dismantling this head scaffold with each setting of the molds, a telescope scaffold was built inside the main upright scaffold which enabled the workmen to disconnect the head scaffold, raise the entire head intact and put in extensions to the uprights, all of which could be done in 2½ hours.

The chimney contains approximately 20,000 cubic feet of concrete, and 850 barrels of cement were used in its construction. The steel embedded in the concrete consists of 10,000 pounds of twisted bars, and 4,000 pounds of old rails, which were placed 12 inches apart, in two layers in the base. The weight of the chimney is approximately 1,430 tons, and the distributed load on its base less than two tons per square foot. Other concrete steel chimneys have been built under the Ransome system, among which is one at Constable Hook, N. J., for the Pacific Borax Co. 150 feet high; one at Jersey City, N. J., for the Central Lard Co., 108 feet high; and one for the Singer Sewing Machine Co. at Elizabethport, N. J., 125 feet high.

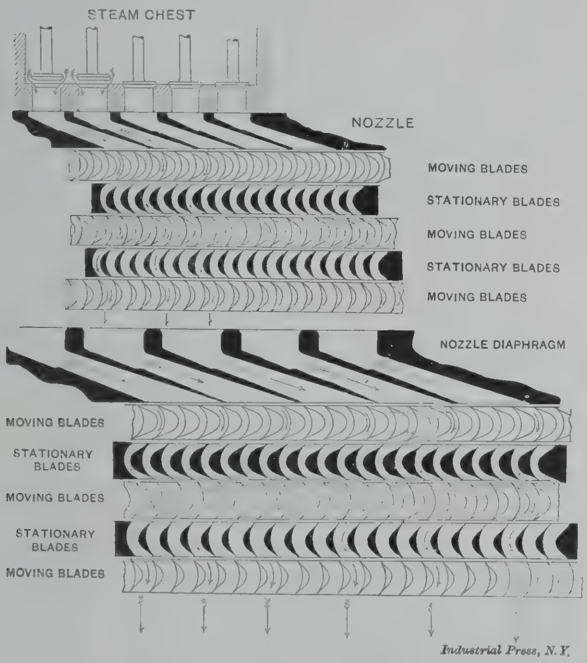
THE CURTIS STEAM TURBINE.

Abstract from Paper read before the American Philosophical Society at Philadelphia, April 2, 1903, by W. L. R. Emmett.

The paper states that the first patent application of C. G. Curtis for an elastic fluid turbine was made in 1895. (The first patent issued to Curtis, we believe, is No. 566,967, date September 1, 1896.) The rapid development of the inventions of Curtis and the placing of them on a commercial basis is evidenced by the fact that the General Electric Company, Schenectady, N. Y., now have contracts for building over 230,000 horse power of steam turbine electric generators. The largest so far built is 7,500 horse power for a power plant in Chicago.

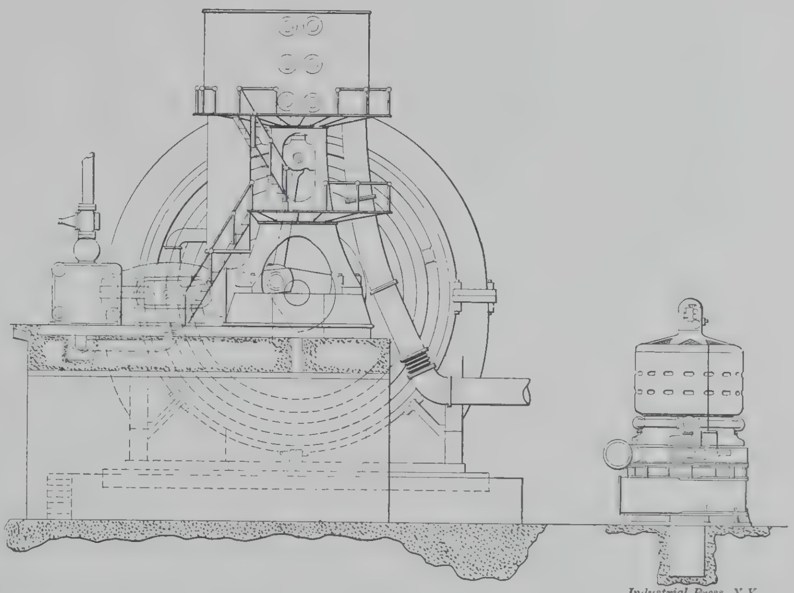
The author says the idea of the steam turbine is quite simple and is similar to that of the water turbine or impulse wheel. The practical difficulty which has heretofore prevented the development of good steam turbines lies in the very high velocity which steam can impart to itself in expansion, and the difficulty in efficiently transferring this motion to wheels at speeds practicable for construction or practical use. Steam expanding from 150 pounds gage pressure per square inch into the atmosphere, is capable of imparting to itself a speed of 2,950 feet per second, and if it is expanded from 150 pounds gage pressure into a 28-inch vacuum it can attain a velocity of 4,010 feet per second. The spouting velocity of water discharged from a nozzle with 100-foot head is 80 feet per second. These figures illustrate the very radical difference of condition between water turbines and steam turbines. In both water and steam turbines the theoretical condition of maximum economy exists when the jet of fluid moves with a velocity equal to about twice that of the vane against which it acts. In water-wheels this relation is easily established under all conditions, while with steam the total power produces a velocity so high that the materials available for simple wheels and vanes are not capable of sustaining a proper speed relation to it under practicable conditions.

The author then briefly describes the principle of operation of the three leading types of steam turbines, viz., De Laval, Parsons and Curtis (see MACHINERY for November, 1902). In reference to the Curtis machine he says that it retains some of the features of its predecessors, but introduces features that make possible lower speed, less weight, higher economy, less cost, etc. Velocity is imparted to the steam in an expanding nozzle so designed as to efficiently convert nearly all the expansive force, between the pressure limits used, into velocity in the steam itself. After leaving the nozzle the steam passes successively through two or more lines of vanes on the moving element, which are placed alternately with reversed vanes on the stationary element. In passing successively through these moving and stationary elements the velocity acquired in the nozzle is fractionally abstracted, and largely given up to the moving element. Thus the steam is first thrown against the first set of vanes of the moving element, and then rebounds alternately from moving to stationary vanes until it is brought nearly to rest. By this means a high steam velocity is made to efficiently impart motion to a comparatively slowly-moving element. The nozzle is generally made up of many sections adjacent to each other, so that the steam passes to the wheels in a broad belt when all nozzle sections are in flow. The governing is effected by successive closing of nozzles and consequent narrowing of the active steam belt. Fig. 1 shows part of the nozzle open and part closed, the arrows showing space filled by live steam.



Industrial Press, N.Y.

Fig. 1. Arrangement of Nozzles and Blades of Curtis Turbine.



Industrial Press, N.Y.

Fig. 2. Comparison of 5000 K.W. Vertical Engine and Curtis Turbine of same Power.

Among the drawings accompanying the paper were elevations and plan of the 500-kilowatt Curtis turbines installed in the Newport, R. I., station of the Massachusetts Electric Companies. (See MACHINERY for March, 1903, p. 375.) Curves were also introduced showing the record of tests made on a turbine driving a 600-kilowatt generator at a speed of 1,500 revolutions per minute. The consumption at a pressure of 140 pounds, 28.5 inches vacuum and no superheat was about 19.2 pounds at 600 kilowatts and 19 pounds at 750 kilowatts. A calculated curve was shown for the same turbine running at the same speed and vacuum, but with a steam pressure of 200 pounds and a superheat of 150 degrees. The steam consumption when developing 700 kilowatts as calculated, is only 16 pounds per kilowatt or slightly less than 12 pounds per horse power.

Fig. 2 shows the Curtis 5,000-kilowatt turbine and generator which is being built for a plant in Chicago, and a 5,000-kilowatt Allis-Chalmers Corliss engine in Manhattan Elevated Railway power station in New York, drawn to the same scale. The respective weights exclusive of the foundations are as 1 to 8 and the saving in foundations alone is an important item. The simplicity of the turbine is in marked contrast to the complication of these excellent engines, which now apparently belong to a past era. It has been estimated that if engine units like those of the Manhattan station were replaced by Curtis turbines, the cost of such replacement will be paid for by the saving effected in three years.

THE TOMSON BOILER.

Der Praktische Maschinen Konstrukteur, Jany. 1, 1903, p. 2.

The boiler, as shown in the cut on the next page consists of two corrugated flue boilers, set upon either side, and combined with a water tube boiler, upon which a steam drum is placed.

In the construction of the flue portion of the boiler, the heads are bumped and flue is set in it in the usual manner. Upon the top of each of the flue boilers there is placed a steam dome 27½ inches in diameter and 26½ inches high, the diameter of the shell itself, in the boiler shown, being 71 inches. The feed pipe enters through the back sheet of each flue boiler while the blow-off cock is set in the bottom of the middle sheet. The two central sheets of the flue boiler are also connected near the bottom by a curved pipe, as shown by the dotted lines of the front elevation. A steam gage is set upon the dome from the top of which there is also a pipe, A_1, leading into the steam space of the drum on the water tube boiler. In this pipe there is a cut-off cock, A. The steam generated in the flue boiler passes out through the pipe A_1 into a steam pipe B_1, placed inside the steam drum B, where it parts with the greater portion of its entrained water so that it escapes into the steam space practically in the condition of dry saturated steam.

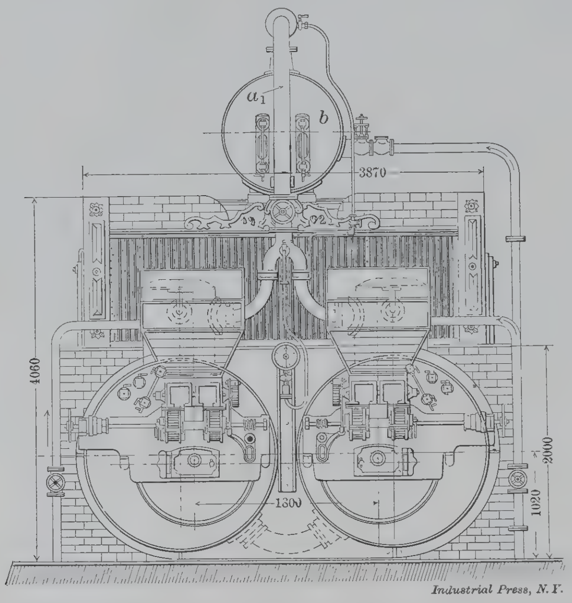


Fig. 1. End View of Boiler.

The grates are the same in both boilers and consist of plain flat bars with a total length of about 6 feet 8 inches, with their front ends resting upon the fire plates and the latter upon a firebrick bridge wall. In the front elevation of the boiler, as shown in the engraving, automatic stokers are in position.

The flue section of the boiler is located in front of the water-tube portion. The latter is double chambered and is of the ordinary construction with welded headers into which the tubes are expanded. These headers are also connected with the steam drum outside the brickwork. This steam drum, in the special boiler under consideration, is formed of five courses, and has a total length of 20 feet 9 inches including the curvature of the heads.

The circulation of the water in the water-tube section of the boiler starts from the feed valve E, whence by means of the pipe E_1, the proper portion of the feed water is led off into the upper drum, where it parts with most of its scale. This is carried back and deposited in the mud-drum C, whence it is regularly washed out through the pipe C_1. The water, thus purified, settles down through the water leg D into the back header, from which it enters the tubes. Here the usual evaporation takes place under the influences of the hot gases, and the circulation causes a mixture of steam and water to be discharged into the front header. From this it rises up to and into the horizontal pipe B_1 that has already been described, where a separation of the steam and water finally takes place. The steam, thus generated and discharged into the steam drum, at last enters the dry pipe F, and passes off through the valve F_1 to the engine. Finally the scale collecting in the bottom of the back header is blown out at regular intervals through the pipe C_2.

Since the flue portions operate as perfectly independent boilers with their own steam domes, they are provided with their own glass water columns, water gages and safety valves. The combustion of fuel in these boilers is carried on in this way: The hot gases rising from the burning of the fuel on the grates in the corrugated flue, impart a portion of their heat to the water surrounding it and convert the latter into steam. The greater portion of this heat is, however, taken up by the water tubes as the hot gases pass over them in a zig-zag course. After leaving the tubes, the gases pass down into a flue G in which there is a regulating damper.

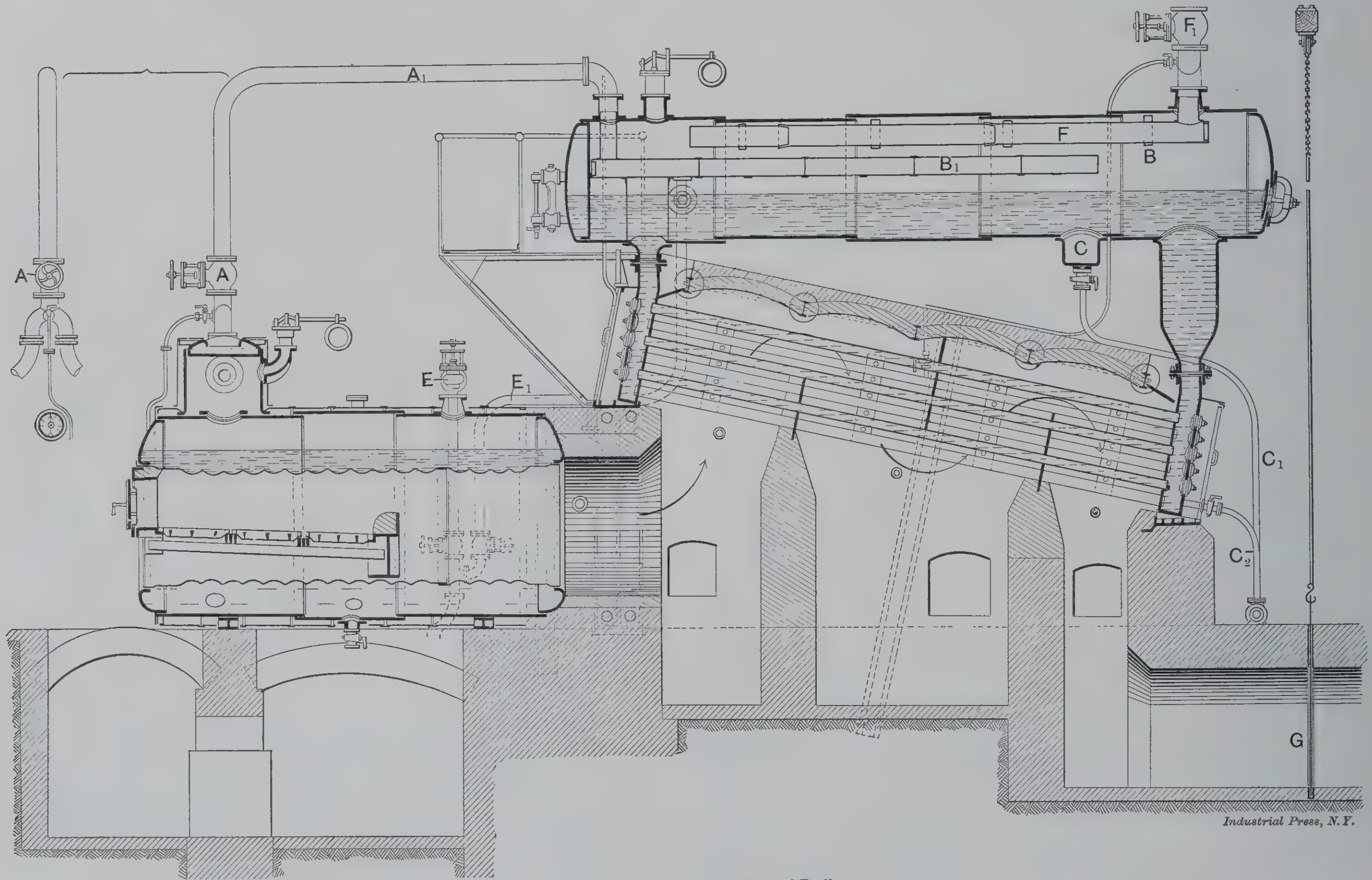


Fig. 2. Longitudinal Section of Boiler.

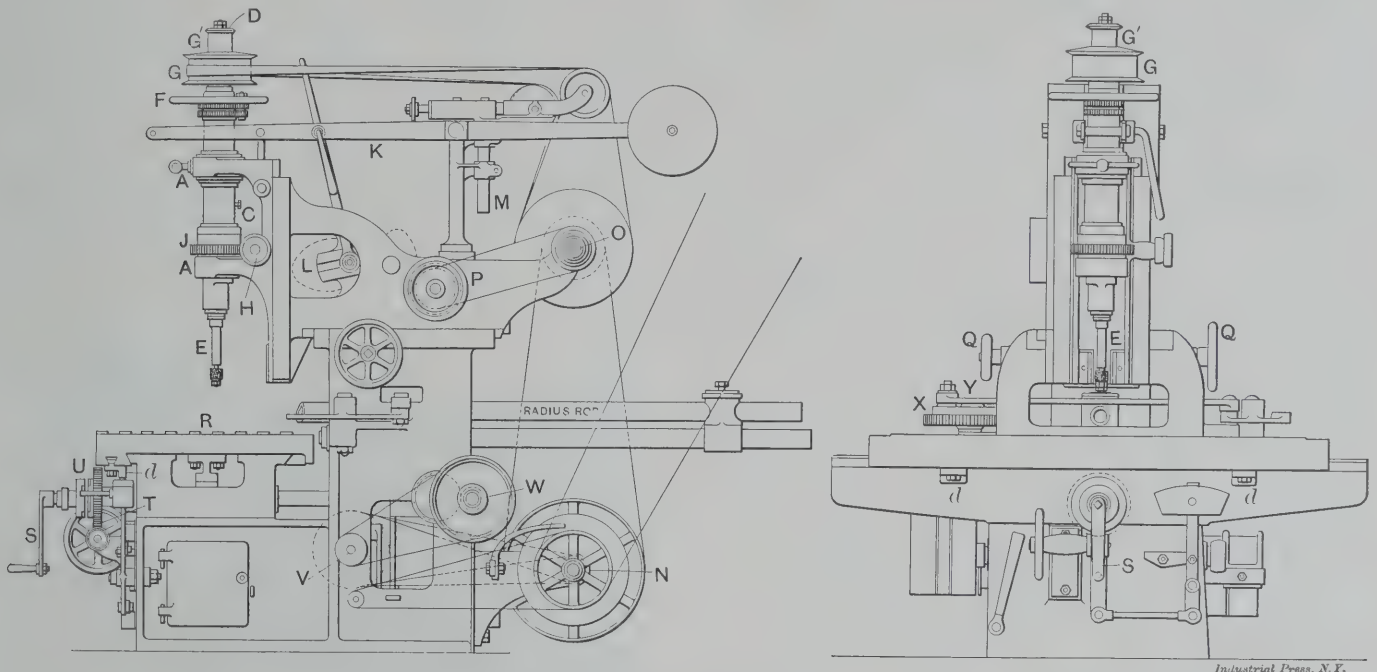
In conclusion, attention may be called to the fact that passages are very conveniently arranged in and about the boiler, so that all parts are rendered easy of access for inspection and repairs. G. L. F.

UNIVERSAL HOLE GRINDING AND LAPPING MACHINE.

Engineering (London), January 16, 1903, p. 63.

In No. XIII. of the series "Grinding Machines and Processes," Joseph Horner describes a universal hole grinding and lapping machine manufactured by Beyer, Peacock & Co., Manchester, Eng., which Mr. Horner says is quite extensively used in British locomotive shops for grinding links and other locomotive parts. This machine employs the sun-and-planet motion by which the grinding spindle is made to describe a circle as it grinds the interior of a hole, or the exterior of a circular piece. Provision is made for varying the diameter of the circle thus described to accommodate varying diameters. The principle was patented by the firm in 1887.

Provision is made for adjusting the height of the tightener pulleys used for belt or cord by carrying their bearings on a pin M, which can be raised or lowered, and clamped in its socket. The reason for this is that the machine shown in this figure has two pulleys, G and G^1, for slower and quicker driving, and the adjustment of M is made to suit the lower or upper positions of the belt.



Grinding and Lapping Machine.

The countershaft N is carried on brackets at the rear of the machine, below. It is speeded at not less than 340 revolutions per minute. The speeding-up to the spindle takes place through an intermediate shaft, O, carried at the rear of the headstock. From O the worm H is belted, and also the feed cones P, whence the elliptical feed wheels are driven. The head has a transverse motion on the upright, sliding on V edges, and adjusted by the hand-wheels Q Q. The main table R is slid longitudinally by rack and pinion, actuated by the handle S, or, slowly through the worm and wheel T, put into gear by means of the clutch U. By means of these two movements exact adjustments are made between the grinding spindle and the work on the table.

From the countershaft N a shaft V is driven with open and crossed belts, whence a drive goes to a back shaft, W. From this a pair of bevel wheels drives a pair of elliptical gears, seen partly at X. These, being driven and reversed by the action of the open and crossed belts, impart a reciprocating movement to a supplementary table by the lever Y, adjusted in a slot disk on one of the elliptical wheels.

In operating one of these machines, the required degree of eccentricity is imparted to the emery-wheel by the hand-wheel, F.* The eccentric orbit in which the emery-wheel revolves is then adjusted centrally with the hole that is to be ground by means of the transverse adjustment on the headstock, by the hand-wheels Q Q, and the longitudinal adjustment of the main table R by the handle S, or by the fine adjustment through the worm and wheel T, put into action by the clutch U,

The correct position is found by inserting the emery-wheel in the hole and revolving the main spindle B, at the same time throwing the internal spindle D sufficiently out of center to bring its emery wheel in contact with the sides of the hole all round. This feed must be effected cautiously, or the spindle may become bent. The vertical reciprocating motion of the emery wheel is either self-acting through the slotted plate L, or, by unclamping the connecting-rod, the lever K may be operated by hand. This motion should be so adjusted that the lower edge of the emery wheel will travel in the downstroke about $\frac{3}{8}$ inch below the bottom of the hole which is being ground, and the top edge about the same distance above the top of the hole on the up-stroke.

For grinding expansion links and blocks the emery-wheel spindle is set concentrically with the main spindle, and is locked in that position by means of a setscrew C, the mandrel used for lapping holes being replaced by one having an adjustable lower bearing. The main table R remaining stationary, the supplementary table is reciprocated by means of the elliptical wheels and levers X, a clutch on the back shaft W of the machine being put into gear for driving this gear. In grinding straight links and blocks, the supplementary table is guided between V strips which fit into the grooves of the main table. But in grinding radial links and blocks, these strips are removed, and the table is bolted to the radius arm, which must be set to the exact radius required.

THE BANKI MOTOR.

Sibley Journal of Engineering, April 1, 1903, p. 265.

MACHINERY has previously referred to the Banki internal combustion motor as invented and developed by Prof. Banki, of Austria. It is well known that in such a motor high initial compression is conducive to high economy, this being the feature that has led to such good results from the Diesel motor. With many mixtures ,however, such as the vapor of benzine and air, natural gas and air, etc., high compression is not possible without resorting to some special expedient, since the heat of compression would be so great as to cause premature explosion in the engine cylinder. Prof. Banki's plan is to obtain the highest practicable compression pressure and at the same time have the fuel mixed with the air required for combustion. With this object in view a fine spray of water is introduced at the same time that the liquid fuel is being sprayed into the cylinder. Both the oil and the water are finely atomized and enter in the form of a spray or mist. During admission and compression the heat transmitted from the cylinder walls and that due to the compression is absorbed in converting the liquid fuel and the water into vapor. The heat required for vaporization is sufficient to keep the mixture at a low enough temperature to prevent premature ignition, and the fuel and water are so proportioned to the load on the engine that ignition will not occur until the end of the stroke. Even then the temperature of the charge is not sufficient to cause ignition and this is consequently provided for by a hot tube in accordance with the prevailing European practice. The engine operates on the common Otto cycle, and governs by cutting out explosions and holding the exhaust valve open on idle strokes. The fuel used is gas, benzine, light gasoline or alcohol.

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* For the principle of this adjustment see February MACHINERY, p. 313.

The principal results of a series of tests on a 20 horse power motor under varying loads are given in the accompanying table. It was not possible to obtain the indicated horse power with any degree of accuracy from the indicator card and so this was computed as closely as possible from the brake horse power tests.

	I	II	III	IV
R. P. M.	209.13	209.67	209.83	210.5
Explosions per minute	91.44	74.68	60.12	42.65
Mean temperature of exhaust, F°.	383.9	384.	366.4	340.
Compression pressure, pounds per sq. in.	235.	235.	235.	235.
Max. pressure of explosion, lbs. per sq. in.	641	626.5	598.	556.
Brake load H. P. (French)	26.38	20.7	15.05	8.21
Benzine per B. H. P. hour, lbs.	.489	.519	.576	.72
Injected water per B. H. P. hour, lbs	2.36	1 71	1.63	1.68
Ratio of injected water to benzine by weight	4.84	3.30	2.82	2.33
Calorific value (lower) of the benzine, B. T. U. per lb.	18,300	18 300	18,300	18,300
Heat used per B. H. P. hour, B. T. U	8,950	9,500	10,550	13.190
Lost in jacket, per cent.	21.35	26 2	23.	27.
Equivalent of useful work, B.T.U.	2,505	2,505	2 505	2,505
Efficiency based on B. H. P., per cent	28	26.4	23.8	19.
Efficiency based on computed I. H. P., per cent	35	34.6	32.9	....
Loss in radiation, exhaust and friction work, per cent	50.65	47.4	53.2	54

There are few, if any, reliable records of gas engine tests which have given efficiencies based on brake horse power as high as those obtained with the Banki motor. Compared with the ordinary type of gasoline or kerosene engines of the same size the efficiency is about double. It is interesting to note the relation of efficiencies of ordinary gas engines when working at compression pressures of 70 and 235 pounds above atmosphere, the former being a value commonly used and the latter that of the Banki engine. The efficiency computed theoretically is about 39.8 per cent. for the former and 56 per cent. for the latter—a relative increase of about 40 per cent. for the higher compression. If, now, instead of taking the theoretical values we use actual efficiencies as determined by test, we have 20 per cent. for the former engine and 28 per cent. for the latter—the same relative increase viz., 40 per cent. This indicates that the introduction of the water does not modify the efficiency, or in other words that the latter is independent of the nature of the working fluid.

BABCOCK & WILCOX BOILERS IN THE MARIETTA.

Journal of the American Society of Naval Engineering, February, 1903. p. 59.

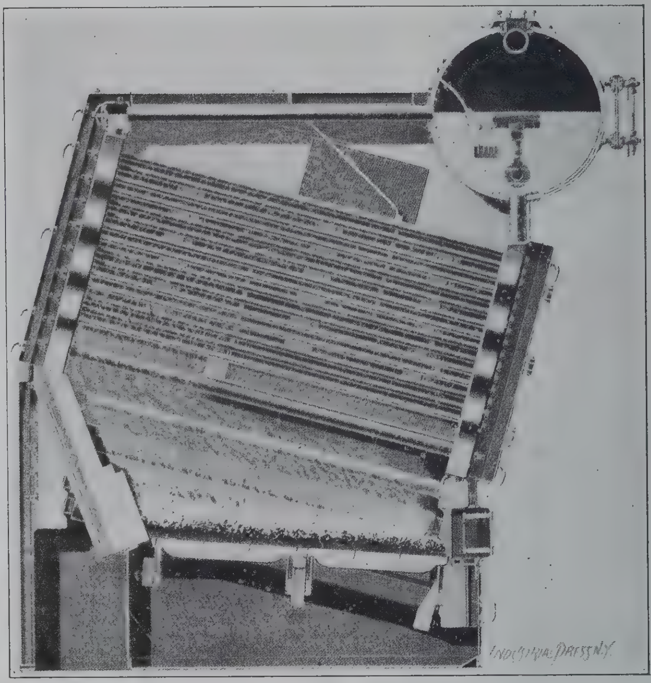
The *Marietta* was put in commission in the United States Navy in September, 1897, and has been in active service ever since. During this period she made the voyage from the Pacific Coast to Santiago, Cuba, to join the naval force of Admiral Sampson. It was only because the country was more concerned in the fate of the *Oregon* that the brilliant service of the gunboat was overshadowed by the work of the battleship and thus the feat of the *Marietta* in reaching the blockading line in practically perfect fighting trim never received the recognition that should have been accorded the smaller of the two vessels that came from the Pacific to battle with Cervera's fleet.

The *Marietta* was fitted with two Babcock and Wilcox Marine type water tube boilers six years ago, which have been in continuous service ever since. During the past five years the *Marietta* has steamed over 80,000 knots, and the boilers have acted so well that it has been very seldom that assistance outside of the ship's force has been required to make repairs. At the present time the boilers are in good condition and everything about them is working well.

The article from which this abstract is made gives a general account of the repairs on the boilers, of their operation, efficiency, etc. About 2¼ pounds of coal per horse power were required for general purposes, including steam used for main engines and all auxiliaries. The grate area is 94 square feet, heating surface 3,664 square feet, and the pounds of coal burned per square foot of grate area, 21.75. The following summary of the advantages and defects of the boilers, as found through their use on the *Marietta*, is given:

(a) *Simplicity.*—In regarding simplicity as a primary salient feature of the boiler, it should be understood that there should be, first of all, simplicity of design. Any steam generator which possesses attachments whose operation is not thoroughly understood nor completely under the control of a water tender who has not absolute confidence in their working, is certain to give trouble and prove inefficient for sustained sea work. Then there should be simplicity of construction. Finally there must be simplicity of operation, for that boiler will soon burn out which practically requires the undivided attention of one skilled man simply to look out that a safe water level is preserved.

(b) *Dryness of steam.*—Dry steam has been furnished the engines under all manner of trying conditions. Both muddy and salt water have been used for considerable intervals, and a high gage of water has been carried in emergencies, especially when getting under way, without producing serious results or causing priming.



Babcock & Wilcox Boilers used in the Marietta.

(c) *Reliable feed maintained.*—A steady and reliable feed can always be maintained. It does not require a specially trained or highly paid water tender to look out for things in the fire room.

(d) *Simple tubes used.*—The tubes are of simple, straight lengths, care being taken to use the highest quality of material in their manufacture. Any attachment to a boiler tube invites trouble if it does not make it dangerous. As the tubes are straight they are very accessible for examination. Each tube can be moved independently of the others, and renewal can be made with ease by the ordinary ship's mechanics using simple tools.

(e) *Rapidity of raising steam.*—Steam can be raised quickly and fires suddenly hauled without subjecting the boiler to undue strain. The fires can also be rapidly forced without any ill effect to the working parts.

(f) *Superior materials used.*—All the material used in construction is of superior quality. As an example, one of the feed water heater tubes was reduced by being burned to a thickness of 34 B.W.G. in one place, and yet this tube resisted a pressure of 200 pounds per square inch from the interior.

(g) *Its economic efficiency.*—The efficiency of the boiler will compare with that of any other marine water-tube steam generator. Under forced-draft conditions, also, its economic efficiency will compare favorably with any straight-tube boiler.

(h) *Efficient circulation.*—The circulation of the water is natural and direct, and is not affected by the roll or pitch of the vessel. The endurance of the boilers of the *Marietta* ought to afford direct evidence as to the circulation of the water within the tubes. As the tubes are of large size, there is a continuous and reliable flow of water through them. The arrangement of the elements is such that the expansion of any one tube is uniform. As provision has been made for the proper expansion of the several elements, a leaky tube or joint is of very rare occurrence.

(i) *Accessibility for repair and examination.*—Practically all the vital parts are accessible for repair and examination. The cost of upkeep is comparatively small. With the exception of the headers, all the parts are procurable from many engineering supply establishments.

Summary of Defects.

(a) *Baffling should be improved.*—The liability of the baffling to burn out, and the disadvantage if not the danger resulting from the excessive accumulation of soot upon these baffle plates, has necessitated much annoying work, besides a great loss in efficiency. The removal of the lower baffle plates cannot be done without cutting out some of the tubes.

(b) *The feed-water heater an incumbrance.*—By reason of the manner in which the feed-water heater is installed the rapid corrosion of tubes cannot be prevented, and some are also liable to burn out. This heater is also very inaccessible for repairs and examination. It is not an integral part of the boiler, but simply an auxiliary that was placed in the uptake in order to increase the efficiency of the boiler.

(c) *Arrangement of grate bars.*—The inclination of the grate bars practically renders the back end of the furnace useless for burning coal, because ashes will accumulate there on account of the difficulty of the firemen cleaning that portion of the grate so far removed from the furnace door. The details of furnace design are neither conducive to efficiency nor to good firing. The inclination of the grate makes stoking difficult and laborious. The combustion chamber is too small. The location of the baffle plates draws the product of combustion to the front of the furnace, thus making it almost impossible to clean the back portions of the grate bars.

(d) *Design of casing.*—Various portions of the casing are too light for the purpose intended. Some parts are almost inaccessible for examination, cleaning and repair. The outboard casing of each boiler comes within a few inches of the bunker bulkhead, and thus the condition of these side casings is difficult to note. By reason of the ashpit doors and the front casing not being tight, but little forced draft pressure can be carried, and when it is used the casing and uptake soon become red-hot. By reason of the leakage of this front casing the cleaning of soot from the tubes cannot be efficiently done.

(e) *Location of steam drum.*—The steam drum is attached to the back of the boiler and this arrangement makes it extremely difficult for the water tenders and firemen to reach the valves that should be within easy access of repair and operation. Whenever men have to operate appliances at great discomfort and inconvenience, it is certain that such attachments will not receive the attention they should and it is even inviting danger to install appliances in such a manner.

(f) *Arrangement of caps.*—As the caps over the 4-inch tubes are so arranged that the pressure in the boiler tends to impair the joint, small leaks frequently occur from careless fitting of the plugs. It therefore requires skilled and intelligent men to fit the plugs.

In considering the defects of the *Marietta's* installation, it should be remembered that the boilers of that vessel were designed over seven years ago. Since that time progressive improvement has been effected in the details of construction of the marine boiler of the Babcock & Wilcox design.

As the installation of this type of boiler in the battleships and armored cruisers now under course of construction will permit more height to be secured than was possible on the *Marietta*, a higher efficiency and increased endurance will be secured from the later design.

THE USE OF REHEATERS IN COMPOUND ENGINES.

Paper read before the April meeting of the N. E. Cotton Manufacturers' Association by George H. Barrus.

The object of a reheater in connection with a compound engine is to reduce the loss occasioned by cylinder condensation. If we compute from an indicator diagram the amount of steam present in the cylinder during certain portions of the stroke, and compare the results with the actual amount of steam admitted to the cylinder from the boiler as determined by a feed water test, a considerable discrepancy will be found. The steam computed from the diagram will always be the less of the two. This shortage in weight is caused primarily by cylinder condensation due to the cooling action which at all times accompanies the operation of a steam engine. The condensation varies in different engines and under different conditions, is seldom less than 20 per cent. and is often as much as 50 per cent. In compound engines the loss occurs in both high- and low-pressure cylinders, but it is generally greater in the low-pressure than the high-pressure cylinder. The extent of the loss and its distribution can best be exhibited by summarizing the results of a number of tests made by the writer on fairly tight Corliss compound engines. The losses were computed from points on the diagrams a little later than cut-off and are expressed in percentages of the actual consumption of feed water. The percentages for the high-pressure cylinder range from 21.1 per cent. to 28.3 per cent. and those for the low-pressure cylinder from 23.7 per cent. to 40 per cent.; the averages, in the instances cited, being respectively 23.8 per cent. and 31.4 per cent.

The reheater is placed in the path of the exhaust pipe of the high-pressure cylinder and as its name indicates it reheats the steam passing through that pipe before it enters the low-pressure cylinder and thereby reduces the condensation in that cylinder. In construction, it consists merely of a shell through which the exhaust steam flows, and is provided with live steam pipes or coils supplied from the boilers, and upon these it depends for its source of heat.

In view of the fact that the loss from condensation is noticeably greater in the low-pressure cylinder than in the high-pressure cylinder, there seems to be good ground for employing special means, such as the reheater furnishes for improving the action in this part of the engine.

The principle of the reheater is the re-evaporation of the water and moisture contained in the exhaust steam discharged from the high-pressure cylinder, and further, in cases where the extent of reheating surface is sufficient, the superheating of the whole quantity exhausted. The effect of this is to increase the quantity, volume, and dryness of the steam supplied to the low-pressure cylinder, and the result is two-fold; first, an increase in the relative amount of power developed by this cylinder on account of the new supply of steam produced; and second, the use of the steam with increased efficiency, owing to the saving of cylinder condensation.

Mr. Barrus then goes on to quote from three engine tests, made respectively on a Greene engine, with cylinders 26 and 50 by 60 inches; a Corliss engine with cylinders 18 and 40 by 48 inches; and a Corliss engine with steam-jacketed cylinders having diameters 16 and 40 by 48 inches.

In the first case the tests show a substantial agreement between the total quantity of feed water consumed per indicated horse power per hour, whether the heater was on or off. In other words, so far as the question of economy was concerned, no advantage was produced by the reheater. This result occurred notwithstanding the fact that the reheater caused a marked improvement in the action of the steam in the cylinders. It appears that the reheater did actually reduce the condensation in the low-pressure cylinder, thus securing at this point the expected gain. When it was in use the condensation here was 4.4 per cent. greater than in the high-pressure cylinder. When the reheater was not in use the difference was 10.6 per cent. Although there was a saving within the cylinder, nevertheless the loss in steam due to that condensed in the reheating pipes to accomplish this result was so great that the net economy was reduced to zero.

The effect of the reheater upon the power developed by the low-pressure cylinder is most noticeable. With practically the same power in the high-pressure cylinder in the two cases, that developed in the low-pressure cylinder was 35.5 horse power less when the reheater was off than when it was in use.

The results of the second test differed in some particulars from those of the first test, but apart from such variations the important fact was brought out that the total steam consumption was almost exactly the same whether the reheater pipes were in use or out of use, thus bearing out the results of the first test. In the third test again practically the same feed water consumption was found both with and without the heater. Here also were substantially the same reductions of cylinder condensation in the low-pressure cylinder and increase of power in the low-pressure cylinder, but the effects were even more marked. With the reheater in use the condensation in the low-pressure cylinder was 1.2 per cent. less than in the high-pressure, while with the reheater out of use the difference increased to 18.3 per cent. This improvement is a large one, but the advantage was lost when it came to counting in the steam required to supply the coils in the reheater. The steam in the low-pressure cylinder was superheated 38 degrees with the reheater in use, but even this help failed to effect a net gain from the use of the reheater. The effect upon the power was quite as marked as upon the condensation. With the reheater off the low-pressure cylinder developed 40 horse power less than the high-pressure cylinder and with it on 18.7 *more* power than the high-pressure.

The three tests referred to, all show the same action with regard to cylinder condensation. There is a great reduction in the condensation within the low-pressure cylinder, but, owing to the loss of steam in the reheater itself the resulting advantage is practically nothing. That the reheater produces no saving, however, is true only when the steam condensed by the reheating pipes is allowed to go to waste and the heat which it contains is lost. In the first engine there was 4 per cent. of the steam thus condensed; in the second, 8.7 per cent.; and in the third, 10.3 per cent. The temperature of the resulting water, with the high-pressures used, is 340 to 350 degrees Fahrenheit. If we assume now that the temperature of the feed water supplied to the boiler is 125 degrees, each pound of condensed steam thus lost carries away with it over 200 heat units, or, in round numbers, 20 per cent. of the total heat of evaporation. Taking the third engine, this loss represents 20 per cent. of 10.3 per cent., or about 2 per cent. expressed in fuel consumption. Consequently, if the condensed steam from the reheater of this engine were returned to the boiler, there would be a saving of fuel, due to its use, amounting to about 2 per cent. It may be safely concluded, therefore, that, although a reheater produces no saving in steam consumption, it will, if properly applied, secure a slight economy at the coal pile.

Apart from the consideration of fuel economy, there is the important question of the effect of the reheater upon the engine capacity. The tests show, without exception, that with the same power in the high-pressure cylinder, the reheater produces a considerable increase in the power of the low-pressure cylinder, and to that extent it increases the capacity of the entire engine. In the case of the first engine the increase was 4.6 per cent. of the total power. In the second engine the increase was 6.3 per cent., while in the third it was 11.8 per cent. This means that an engine without reheater must have larger cylinders, to do the same work, than an engine with reheater; or, if the cylinders are of the same size, there is more reserve power in the engine which is provided with a reheater. This feature of the subject makes the reheater advantageous even if it produces no other gain.

SURFACE CONDENSER USING MOIST AIR AS THE CONDENSING MEDIUM.

Engineering News, April 2, 1903. p. 305.

Arthur Pennell, Kansas City, Mo., is the inventor of a surface condenser using moist air for the cooling medium without the use of a fan blower to force the air through the condenser tubes. A cylindrical shell similar to a horizontal tubular boiler, 78 inches in diameter, is stood vertically over a cistern. The shell is carried above the upper tube sheet to increase the draft. The tubes are of steel, 4 inches in diameter, and are closely spaced. A centrifugal pump circulates about one-half gallon of water per minute from the cistern below the condenser up over the upper tube plate, where it is so diverted as to flow down equally through each tube and form a film of water on the interior surfaces. The exhaust steam enters at the side of the shell and is caused by baffle plates to circulate among the tubes, condensing as it goes and falling to the bottom of the shell where it is drawn off by a vacuum pump to the hot-well.

The condensing action is as follows: The exhaust steam in the shell heats the tubes and the water film on their internal surface; the latter evaporates, at the expense of the latent heat of the steam, into the air in the tubes, saturating the air at its own temperature. Hot saturated air is much lighter than the normal atmosphere, so an upward current ensues, the hot vapor-laden air rushing up the flue and carrying off the heat into the atmosphere, while fresh air enters from below to replace it and be saturated at a higher temperature in its turn. The film of water on the cooling surface is secured without interference with the ascending air currents and also without the use of sprays through small orifices, likely to become clogged with rust or sediment.

Two condensers of the type above described were erected early in 1898 at No. 3 Power House of the Armour Packing Co., in Kansas City, Mo. Tests of a condenser of this type made in April, 1901, showed the average amount of steam condensed per square foot of cooling surface per hour to be 2,038 pounds. The air entering the condenser had a temperature of 62 deg. and it left at a temperature of 106 deg. The following below gives the principal figures of the test. The condenser took the steam from a 30 × 58 × 48-inch engine running at 45 r. p. m. The trial lasted nine hours and the tabulated data follow:

Average steam pressure at engine by gage....	139.8	pounds
Average vacuum per engine gage.............	18.38	inches
Average vacuum per mercury column........	17.50	inches
Average temperature in condenser..........	123.7	deg. F.
Average temperature of circulating water.....	116.4	deg. F.
Average temperature of city water...........	52	deg. F.
Average temperature of outside air...........	62	deg. F.
Average temperature saturated air, condenser	106	deg. F.
Average draft in stack of condenser........	1-10-inch	
Average humidity of outside air..............	67	per cent.
Total amount of steam condensed............	71,550	pounds
Average amount of steam condensed per min..	132.5	"
Average amount of steam condensed per hour	7,950	"
Total amount of circulating water used......	1,032,060	"
Average amount used per minute............	1,911.22	"
Total amount of city water used..............	31,150	"
Average amount used per minute.............	57.7	"
Ratio of circulating water & steam condensed	1 to 14.42	
Ratio of city water and steam condensed......	1 to 0.435	
Average horse power of engine during trial, per indicator cards	569.74	
Average hourly weight of steam used, per I.H.P.	13.95	pounds
Average horse power required to run air pumps	10½	H. P.
Average horse power to run circulating pump	3	H. P.
Total amount of condensing surface..........	3,900	square feet
Amount of steam condensed per. sq. ft. surface, per hour	2.038	pounds

* * *

An attempt to fix the velocity of light with greater accuracy, using the toothed-wheel method of Fizeau under improved conditions, has been described by M. Perotin. In previous experiments, the beam of light, was made to travel a distance of 12 kilometers (7.452 miles) and back, but in the recent trials it was reflected from a mirror placed at a distance of 46 kilometers (28.566 miles) from its source. From 1,109 observations the velocity has been found to be 299,880 kilometers (about 186,225.5 miles) per second, with a probable error less than 50 kilometers.

RESULTS OF TESTS ON HIGH-SPEED ENGINE.

A test was recently conducted at the Worcester Polytechnic Institute for the Buffalo Forge Co. upon one of their horizontal high speed engines having cylinders 12 by 12 inches and scheduled to run at 300 revolutions a minute. Profs. Sidney A. Reeve and C. M. Allen conducted the test, and the results are a fair criterion of what may be expected from a well-designed single-valve engine of this type under good conditions.

The engine was erected upon temporary foundations on the power house floor and belted to a quill upon the main line shaft. Steam was drawn from the vertical boilers through 36 feet of permanent covered pipe and 17 feet of temporary naked piping. The exhaust was led through three elbows and 14 feet of pipe into a surface condenser with which all other connections were broken. During the tests the quality of the steam, as determined by the calorimeter, was practically dry and saturated. The condition of the steam supplied to the engine was frequently investigated.

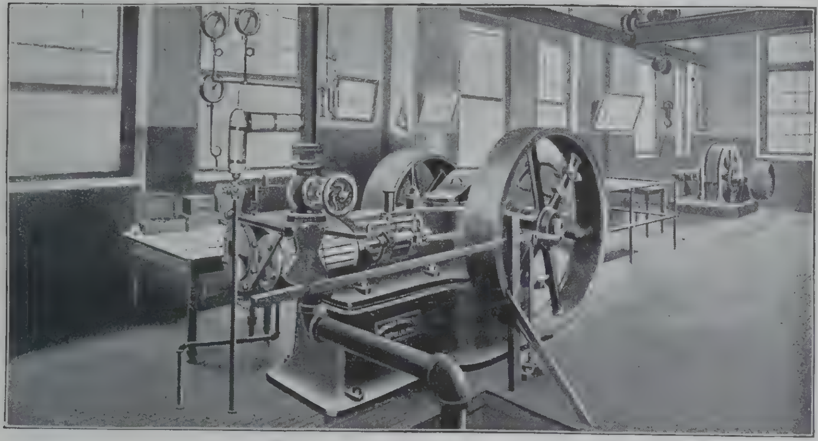


Fig. 1. Engine in Laboratory of Worcester Polytechnic Institute.

In order to insure absolute steadiness of power developed, the engine's governor was blocked into such positions as would give the various cut-offs desired. The speed was maintained constant by insuring that the load was at all times greater than that which the engine would drive, the balance being made up by a second engine belted to the same line shaft. The governor of this second engine performed the regulation for the entire system. The speeds recorded are therefore no record of the action of the governor of the engine under test. During any one test the speed was sensibly constant.

TABLE OF RESULTS.

Condition of Engine.	Gage Pressure.	Revolutions per min.	Power.	Water Rate.	Cylinder Efficiency.	Thermo. Efficiency.
Normal cut-off, 125 lbs.	124.75	312.1	123.5	27.5	55.8%	9.16%
Normal cut-off, 80 lbs.	79.96	301.8	71 55	31.3	59.2%	8.12%
25% under load, 80 lbs.	79.85	297.7	56.18	33.1	56.0%	7.68%
50% under load, 80 lbs.	81.90	304.6	37.09	35.4	51.9%	7.19%
75% under load, 80 lbs.	81.50	306.3	16.65	51.1	36.1%	4.98%
25% over load, 80 lbs.	80.57	301 3	87.00	34.0	54.4%	7.49%
Normal cut-off, condensing.	80.95	311.3	87.64	27.7	66.8%	9 21%

The weight of the steam consumed for all of the tests was determined by condensing the exhaust, care being taken, when making the "non-condensing" tests to have the pressure in the condenser exactly at the pressure of the atmosphere, at the same time allowing no vapor to escape. During the "condensing" tests the vacuum maintained in the condenser—about 22 inches—was the best that could be in view of the limited size of the condenser.

This arrangement left the steam pressure as the only variable in any one test and this was kept as nearly constant as possible. The duration of each test was twenty minutes, but the engine was always kept in continuous operation for at least one hour before entrance upon a test.

The indicator readings were taken from a pair of Thompson instruments and the indicator rig was built especially for the tests. It contained no geometric error; the error from lost motion was imperceptible; the length of cord involved was eight inches for one indicator and 24 inches for the other. The indicator cocks were screwed directly into the cylinder ports. All gages and thermometers were calibrated.

The friction of the engine was also determined, when running empty. Because of the difficulty of making this determination with reliability, two different indicators and six sets of springs were employed. The result of the whole is that the engine's friction is estimated at very close to 3 horse power or 4.3 per cent. of the engine's rating. The unusual lightness of this friction led to the repeated checking of its observation, as just noted, before accepting the result.

The results of the tests are given in the accompanying table. The only explanation needed is perhaps with regard to the column of "cylinder efficiency." These figures show the proportion of the heat available for work under the conditions actually prevailing at the time of the test which the engine succeeded in converting into work. That is, it is the percentage of the theoretically possible which the engine actually attained. In this column 100 per cent. would be the record, not of an engine which converted all of its heat supply into work, for no engine could imaginably do that, but of an ideally perfect engine operating under the conditions under which the Buffalo Forge Company's engine operated. The results figured in this way prove to be good standard ones.

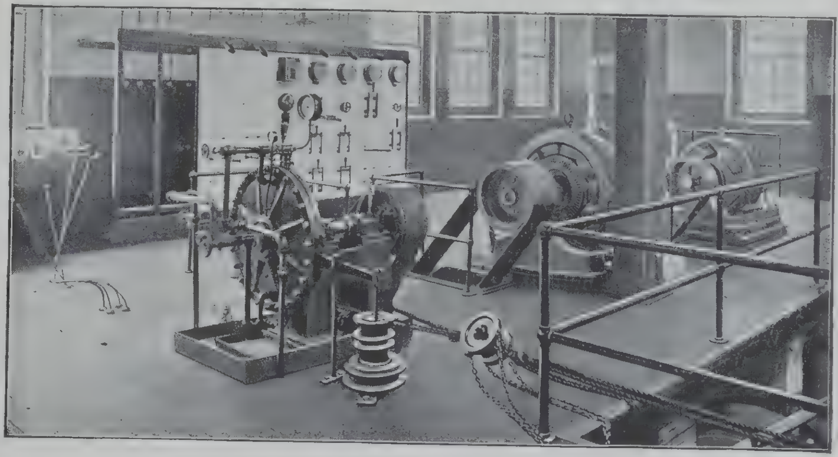


Fig. 2. Alden Absorption Dynamometer used in Conducting the Engine Tests.

In addition to the efficiency tests, was run a 36-hour endurance test under 80 pounds of steam pressure and a load of 69.67 horse power. During its imposition two observations of efficiency were made and their results are scheduled with the others. As to the showing made by the engine under this endurance test, it can only be said that no fault or suggestion of fault developed. The engine ran smoothly and quietly, with cool bearings, throughout the test. When shut down it was apparently ready to start upon a second similar run with equal success.

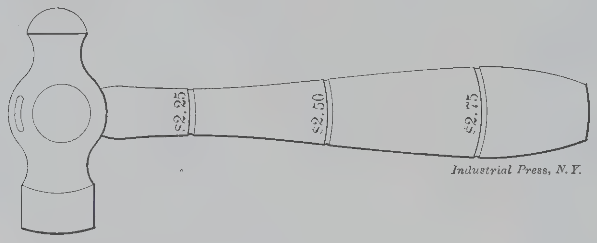
As to the general design and construction of the engine, regarding which an inquiry was made by the builders when the tests were arranged for, Profs. Reeve and Allen report that with all that could be seen upon dismembering the engine, both before and after the series of tests was run, they were very favorably impressed. For simplicity, compactness, good distribution of metal, and convenient arrangement, it provoked favorable comment from all who saw it.

LETTERS UPON PRACTICAL SUBJECTS.

THE GRADUATED HAMMER.

Editor MACHINERY:

While employed in a small shop, in the suburbs of Chicago, I witnessed what was to me a very amusing incident. A new man was put to work on the bench beside me who proved to be a wandering machinist who had worked all over the country—a "journeyman for further orders" as it were. He had been in the shop three or four days when the foreman chanced his way and wishing to borrow a hammer he asked Mr. Wanderer for the loan of his. On picking it up he started to examine the handle which certainly presented an odd appearance, as it had been graduated with knife cuts in the manner shown in the sketch. Being somewhat curious I listened attentively and was enlightened by the following conversation:



The Graduated Hammer.

Foreman—"What the —— are all the marks and numbers cut in this handle for?"

Wanderer—"So's I can tell where to take hold of it."

F.—"That explanation is about as clear as mud."

W.—"The next time I am doing a little chipping just watch me."

A little later—Enter the foreman, glancing with a puzzled look at the Wanderer who is busily engaged chipping.

Foreman—"Well, I see you are holding that hammer near the head. What is that for?"

W.—"For? Why don't you see that this is the $2.25 mark? that's what I'm getting here. Make it $2.50, and I hold it in the middle. Do the handsome thing and give me $2.75 and you will see me hold it at the end."

The foreman walked away laughing. But that night when the Wanderer received his pay envelope it contained a card saying that in the future his pay would be $2.75 per day.

R. A. LACHMANN.

Chicago, Ill.

THE STRENGTH OF CONCRETE.

Editor MACHINERY:

The writer recently assisted at a series of tests of a number of small concrete arches and the results of these experiments give a good idea of the strength of concrete and may prove of interest to some of the readers of MACHINERY. These arches were of 18 inch span, having a rise of 7 inches and were 6 inches wide and 6 inches thick at the crown. No rods, wires, or other means were employed to give the concrete extra strength. The ends of the arches were suitably supported so as to obtain the same result as if they had been made between two I-beams in a building. A concentrated load was applied to the crown of each arch.

The poorest arch, made of 1 part Portland cement, 2 parts sand, and 5 parts ¾-inch broken stone, stood an ultimate load of 13,200 pounds. This was a poorly constructed arch, having been rammed very little and the ingredients not well mixed. Arches composed of 1 part Portland cement, 2 parts sand, and 4 of ¾-inch broken stone, stood ultimate loads of from 14,000 to 26,000 pounds.

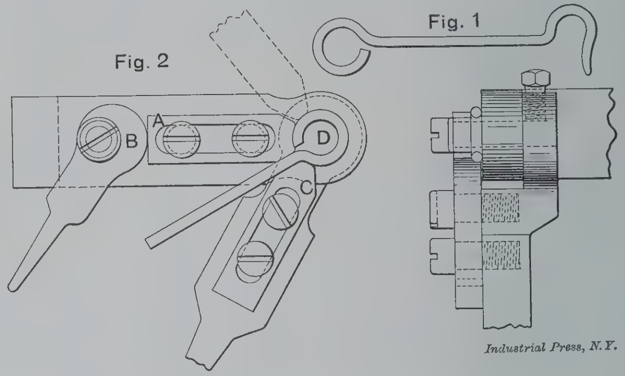
We also made a small block of concrete (proportions 1, 2, and 5) which was simply placed in a mold. After a period of thirty days, a pressure of 637 pounds per square inch was required to crush it. Another interesting experiment was that of imbedding a twisted wrought-iron rod, of ¼-inch square section, in 12 inches of concrete. After becoming thoroughly set, a pull of 1,450 pounds was required to loosen the rod.

New York City. CHAS. G. PEKER.

FIXTURES FOR FORMING WIRE HOOK.

Editor MACHINERY:

The article on wire bending, by C. D. King in the December number of MACHINERY, calls to mind a device used in a wire shop for forming hooks such as are shown in Fig. 1. The first part of the forming operation is performed in a fixture similar to that described by Mr. King except that the sliding lever *A*, Fig. 2, is substituted for the pins that hold the wire while it is being bent. The screws allow this finger to slide freely back and forth when operated by the cam *B*. The end of the finger is beveled at the proper angle to bend the wire radially at the end of the stroke of the lever *C*. With this arrangement the wire can be placed in the fixture and the cam *B*, swung down so that the finger binds the wire firmly against the pin *D*. The lever *C* is then swung from the dotted position to that shown by the full lines, when the eye is completed, thereby saving the second operation that is necessary with Mr. King's fixture.



First Operation for Forming the Hook.

The hook is then bent on the other end by means of the fixture shown in Fig. 3. To the base *A* is fastened the former *B*, having a clamping finger *C* that is operated by the cam *D*, similar to the cam and finger used for the first operation. The lever *E*, to which is fastened the finger *F*, is pivoted beneath the former *B*. Finger *C* should slide freely on the screws but *F* should be fastened securely to the lever *E* so that it cannot slip. The wire is placed in position and the finger *C* is brought forward by the cam *D* thereby producing the first bend; the lever *E* is then thrown over to the position shown in the cut, thus completing the hook. These fixtures do very well for a small quantity of such work, but, of course, in large shops engaged in the bright wire business such pieces would be produced with automatic machines. NIX.

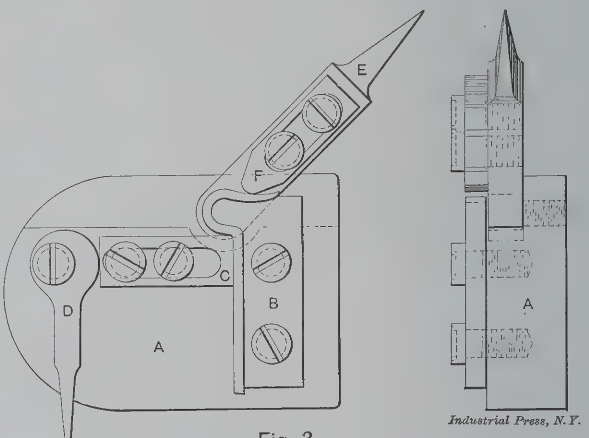


Fig. 3

Second Operation for Forming the Hook.

THE METRIC LEADSCREW.

Editor MACHINERY:

In the conclusion of an interesting article on the metric system (MACHINERY, April, 1903,) Mr. John M. Barnay remarks: "Why, under the circumstances, the foreign buyer should risk the delay and additional expense connected with extras, such as furnishing metric screws, does not seem clear." The "circumstances" spoken of are that it is possible, by the simple addition of a translating gear, to convert the "inch measurement" screw into a metric one, and his letter explains how this can be accomplished. Having given a great deal of study to the subject of screw cutting, both theoretical and practical, I must certainly differ with Mr. Barnay and hope to be able to show why the screw cutting lathe must of necessity be fitted with a screw whose pitch can be expressed in the system of the pitch of the work. I use the word "necessity" advisedly.

Present-day competition, in the engineering trades especially, demands that work be accomplished with the least resistance possible. I am aware that in screw cutting practice the backing belt is often used to return the carriage to its starting point, but would any workman if cutting a long screw, of the same pitch, or a multiple of the pitch of the leadscrew, attempt to do the work in this manner? Personally, even for the shorter lengths of screws, I am not in favor of backing by belt and believe it is beyond dispute that loss of time must be entailed by so doing. In certain cases of exceedingly coarse or odd pitches, no doubt, unless the workman be skilled in catching the thread the backing belt is much handier than the English method of chalking—running back by hand and meshing again when the chalk marks coincide—but for all ordinary methods of work, the chalking method is the only one that economy of time will permit.

Now if a lathe be fitted as mentioned by your correspondent, back belting would be absolutely imperative with the result that on all simple work much time would be lost. As the translating gear has 127 teeth it will be necessary to allow the spindle to make at least 127 turns before the tool-point would coincide with the thread being cut—if we disengage the nut—and in some cases two, three, or more times 127 turns, depending upon the pitch in millimeters being cut. Hence the backing belt must be used for every possible pitch in millimeters no matter how long the work, it being quite apparent that to run through so many idle turns could not be permitted. **Francis W. Shaw.**

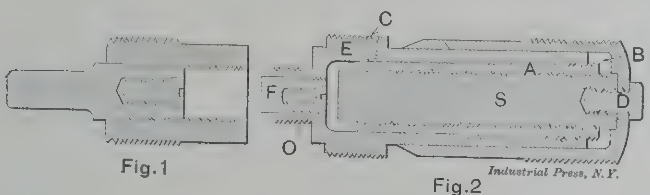
Birmingham, England.

AN INSIDE MICROMETER.

Editor Machinery:

In the December, 1901, number of Machinery, I described a small inside micrometer for measuring holes from 1 inch to 2½ inches. This tool has proved so successful that I have since designed a similar micrometer adapted to measuring, by use of extension rods, from 2 inches up to any size of hole and having one inch adjustment of the measuring screw.

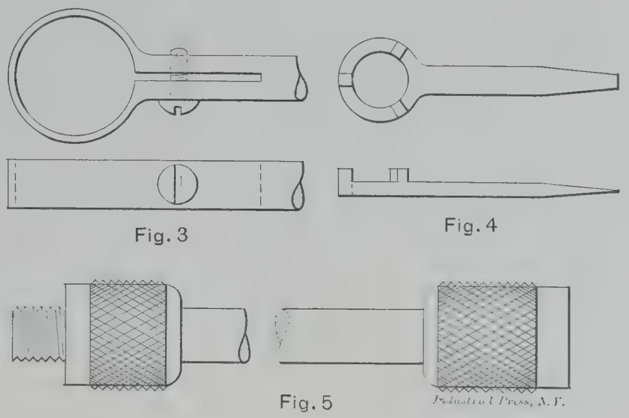
Referring to the section shown in Fig. 2, the measuring screw *S* is secured to the thimble *B* with the screw *D*, the head of which is hardened and forms the anvil. By loosening this screw *D*, the thimble can be rotated to compensate for wear. The wear of the measuring screw and nut is taken up by screwing the bushing *A* into the frame with the wrench shown in Fig. 4. This bushing is split in three sections for about two thirds of its length on the threaded end. The three small lugs on the wrench fit into these slots. The handle end of the wrench is a screw driver which is used for manipulating the set screw *C*. The bushing is made an easy fit in the frame on its plain end and tapered, as shown, on its outside threaded part. This thread being the same pitch as the measuring screw, adjustment for wear does not affect the reading of the micrometer. This manner of adjustment brings the nut squarely down on the measuring screw for its whole length, presenting the same amount of wearing surface after adjustment as when new.



Inside Micrometer.

The point *F*, which is hardened on its outer end, screws into the frame and is secured by the taper-headed screw *O*, which screws into and expands the split and threaded end of the point *F*. The handle, Fig. 3, clamps over the knurled part of the frame for use in small, deep holes. The rods, six in number, running from 1 to 6 inches inclusive, are made by screwing a sleeve onto a rod with a hardened point and locking it with a taper-head screw on its threaded and split end, the same as in the point *F*. The extension pieces Fig. 5, are adjustable, on their socketed ends, in the same way, and run in lengths of 6, 12, 18 inches, etc.

Watervliet, N. Y. **M. H. Ball.**



Wrench and Extension Rods for use with the Inside Micrometer.

MORE ABOUT CUTTING SPIRALS.

Editor Machinery:

In the March issue of Machinery there appeared an article, by Mr. J. T. Giddings, on the subject of cutting spirals on the universal milling machine. While employing the same method, in whole or in part, for the calculation of all ordinary cases, I think that my method in case of fractional or decimal leads is preferable and more accurate than that described. To illustrate, let us consider the same examples that were used by Mr. Giddings.

The first example was to find the change gears for a lead of 1.25 inches to one turn. Then $\frac{1.25}{10}$ is the ratio of the gears, and instead of reducing the expression to the fraction ⅛, multiply both terms by 100 which gives $\frac{125}{1000}$ and resolving this into factors, we have:

$$\frac{125}{1000} = \frac{5}{10} \times \frac{25}{100} = \frac{30}{60} \times \frac{25}{100} = \frac{24}{48} \times \frac{25}{100} = \frac{36}{72} \times \frac{24}{96} = \frac{30}{72} \times \frac{24}{80}$$

which means that gears of 30 and 25 teeth can be used as the two driven gears when gears of 60 and 100 teeth are used as drivers, or any other of the above combinations may be used.

In the second example Mr. Giddings takes a lead of 2.22 inches to one turn and, by finding the gears by his method, does not find those that will give exactly this lead. By the method proposed we have:

$$\frac{222}{1000} = \frac{6 \times 37}{10 \times 100} = \frac{36 \times 37}{60 \times 100} = \frac{24 \times 37}{40 \times 100} = \frac{24 \times 74}{80 \times 100} = \frac{24 \times 37}{80 \times 50}$$

or several other combinations might be used which would give exactly the required lead, the numbers above the line representing the driven gears and the numbers below the line the driving gears. It is more essential to cut a short lead accurately than a long one, since a slight difference in a short lead will change the angle more than a greater difference in a longer lead.

If the lead should be given in thousandths, multiply both terms by 1,000, or what is perhaps more easily remembered, call the required lead a whole number and annex as many ciphers to the 10, in the denominator, as there are decimal places in the required lead. For example: Given a lead of 2.176 inches, the ratio of the gears is $\frac{2176}{10000}$. If the required lead should be given in the form of a fraction that would reduce to a circulating decimal, as 1-3, 1-6, 1-7, etc., it should not be reduced to a decimal but should be calculated in the following manner. Example: Given a lead of 21-3 inches, to find the gears, Then:

$$2\tfrac{1}{3} \div 10 = \frac{7}{3} \times \frac{1}{10} = \frac{70 \times 24}{72 \times 100} = \frac{56 \times 24}{72 \times 80}$$

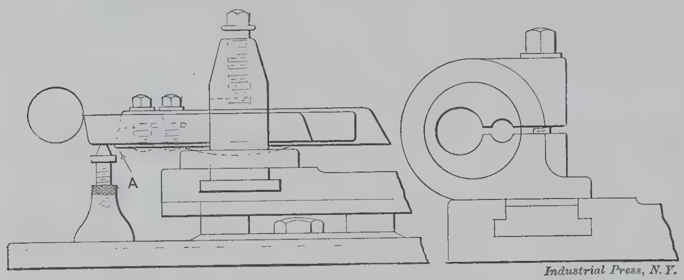
Spiral Miller.

PATENT CUTTING-OFF TOOLS—GRADUATIONS ON THE COMPOUND REST.

Editor Machinery:

I was much pleased to read Mr. S. Byron Welcome's article on patent tool holders in a recent number of Machinery, as it has always been somewhat of a mystery to me why such an obvious time-saver as the tool holder has not been more generally adopted. In one respect, however, I must differ with Mr. Welcome, and that is in regard to his statement of the failure of the manufacturers to produce a good cutting-off tool. The writer feels sure that the fault is not with the makers but rather with the users (or abusers) of the tool.

As for the off-set cutting-off tool, while it is at times very desirable for cutting off work close to the chuck, it is also necessary that it should be set on the center in order to cut to the center; and to accomplish this it is, in nearly every instance, tilted on the tool post in such a manner that all of the side clearance is on one side, instead of being evenly divided as is necessary to insure the tool clearing itself as it enters the cut. The result is that the blade inevitably breaks and the weakest part of the holder, *A* in Fig. 1, is bent downward. If, however, the blade is supported directly underneath the cutting edge, as shown in the sketch, by means of a small jack, or even an ordinary bolt and nut, the tendency to spring and dig into the work is entirely eliminated. This also prevents disagreeable chatter which generally results when trying to run at a moderately fast cutting speed such as the self-hardening blades are designed for.



Figs. 1 and 2. Patent Cutting-off and Boring Tool Holders.

There is no necessity for using a quart of lard oil every time a piece of steel is cut off; a small brush dipped in the oil will supply all of the lubrication that is needed. The makers of the patent tools specifically state that they are to be ground on the end only, yet how many mechanics will grind off the top of the blade with the idea of taking off a nice curling chip. When tool holders fall into such hands it is only natural that the whole lot should be condemned as no good.

Of boring tool holders, one of the best that the writer has seen is shown in Fig. 2. The eccentric holes in the bushing not only permit the use of a large or small bar but slight variations in the height of the cutting edge are thus provided for. If it is an advantage to have the bar very stiff, one end may be run in a bushing fitted to the tapered hole in the tailstock spindle.

A few words on the subject of graduations: The base of the compound rest, the cross feed screw and the taper attachment have graduations to facilitate setting, which are very useful when intelligently used. It should, however, be remembered that in using the compound rest, the tool must be set on the center or the bevel turned will not be the one indicated by the graduations on the base of the rest. The same applies to the taper attachment. A man will turn a taper, take his tool out and grind it and then, after replacing it, wonder why the next piece turned has not the same taper as those he has previously done. It never will have the same taper unless the tool is set at the same height and this is a somewhat difficult thing to do with the common tool post. The best method is to take the work out of the centers and set the tool exactly on the center. I have yet to meet the old-fashioned workman with his calipers and scale who could work around the young fellow who uses his micrometers in conjunction with the graduations on the cross feed screw.

New York City. H. J. Bachman.

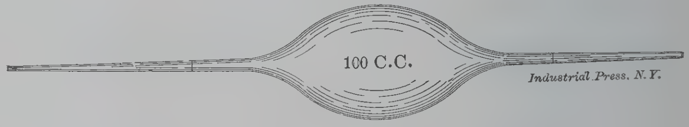
VISCOSITY OF OILS.

Editor Machinery:

The design and operation of bearings in machinery rest on the effective action of the lubricant, and failure or success depends not only on mechanical conditions, but on the lubricant chosen. The objects in the use of lubricants are to reduce loss of power by decreasing friction, to minimize the wear of parts, and to prolong the life of the machine. For some years experimenters have recognized that the value of lubricating oil depends upon two important properties, namely, viscosity and body. Professor Thurston early pointed out that the case of perfect lubrication was capable of exact mathematical treatment. In 1886, Professor Reynolds published an elaborate analysis of such a case. In any well fitting journal in which perfect lubrication exists, the friction is determined by the speed, the pressure, and the viscosity of the oil. Varying any one of these factors while keeping the others constant, there is some value of the variable for which the coefficient of friction is a minimum, which at the same time marks very nearly the limit of the variable for perfect lubrication.

The primary requisites of a good oil are that it shall wet the surface of the bearing, for this, in general, gives the lowest friction. It shall not contain free acid, or become decomposed by the metals with which it comes in contact. It shall not contain any volatile matter, or become thickened by oxidation. Viscosity is the property of oil by virtue of which lubricants form a comparatively thick film between the rubbing surfaces. A condition essential to the formation of such films is that the rubbing surfaces have a very slight inclination to each other in the direction of their relative motion. This condition is generally fulfilled by the slight difference in the radii of the journal and the bearing, due to the original looseness of fitting, or to wear. The films formed under such conditions vary from .00021 to .00077 of an inch under loads varying from 27 to 270 pounds per square inch. Since the value of an oil as a lubricant depends upon viscosity to a far greater extent than it does upon body, the following experiment has been devised as a simple means of determining viscosity without regard to body.

One of the simplest and best methods for comparing viscosity is by the use of the viscosity pipette. This method is used by the Pennsylvania railroad for testing their oils, and though it may lack scientific accuracy, it serves to compare readily the viscosity of different oils for all practical purposes. By this method the viscosity is shown as the time in seconds required for a certain volume (usually 100 cubic centimeters) to flow through a standard orifice. This orifice is of such a size as to allow 100 cubic centimeters of water at 100 degrees Fahrenheit to flow through it in 34 seconds. This time is not proportional to viscosity but it gives a means of arranging fluid lubricants in the order of their viscosity. It is obvious that this method is useless for semi-solid and solid lubricants. In order to determine viscosity by this method, the pipette holding 100 cubic centimeters of the fluid is mounted on a lamp stand with the lower end dipping into a cup to catch the oil as it flows from the orifice. The oil tested is drawn up into the pipette, and the time it takes for 100 cubic centimeters to run out is noted. This is called the viscosity of the oil for that particular temperature.

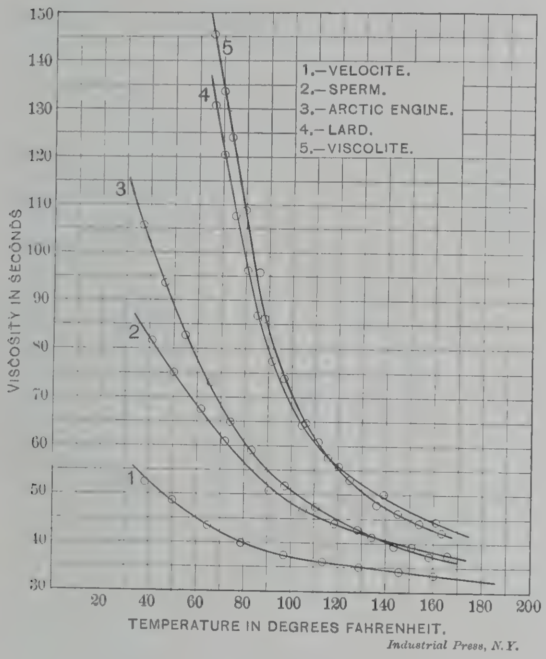


Viscosity Pipette.

With such an apparatus arranged in the manner described above, the writer made a number of tests on both animal and mineral oils at various temperatures. The results were plotted in curves thus allowing the viscosities of the different oils to be compared at any temperature within the range of the test. Curves 1, 3 and 5 are results of tests on mineral oils; while curves 2 and 4 are tests on animal oils. From these curves it can readily be seen that the viscosity of all the oils becomes less as the temperature increases. With increase of temperature, the viscosity decreases proportionally faster for those most viscous at the ordinary temperature. The rate of decrease is not the same for all oils. As the temperature rises, the organic or animal oils, in general, show less rapid decrease than the mineral oils. It has been found by other tests that, of oils having the same viscosity at any temperature, the organic oils are ordinarily more oily. In the samples tested the viscosities of the mineral and animal oils approach each other as the temperature rises until, at 240 degrees Fahrenheit, they are very nearly equal.

Therefore, since viscosity is the chief property upon which the value of an oil as a lubricant depends, the above method, while it does not give a scientifically correct result for viscosity, does furnish a simple method for comparing the viscosities of different oils. This, in turn, will determine the value of the oil as a lubricant at the temperature at which it will have to operate in the machine in which it is used. It will thus enable the user to select an oil which will give him the best satisfaction under the conditions which exist in the machinery, in the bearings of which the lubricant is to be used.

ARTHUR W. COLE.



Industrial Press, N. Y.

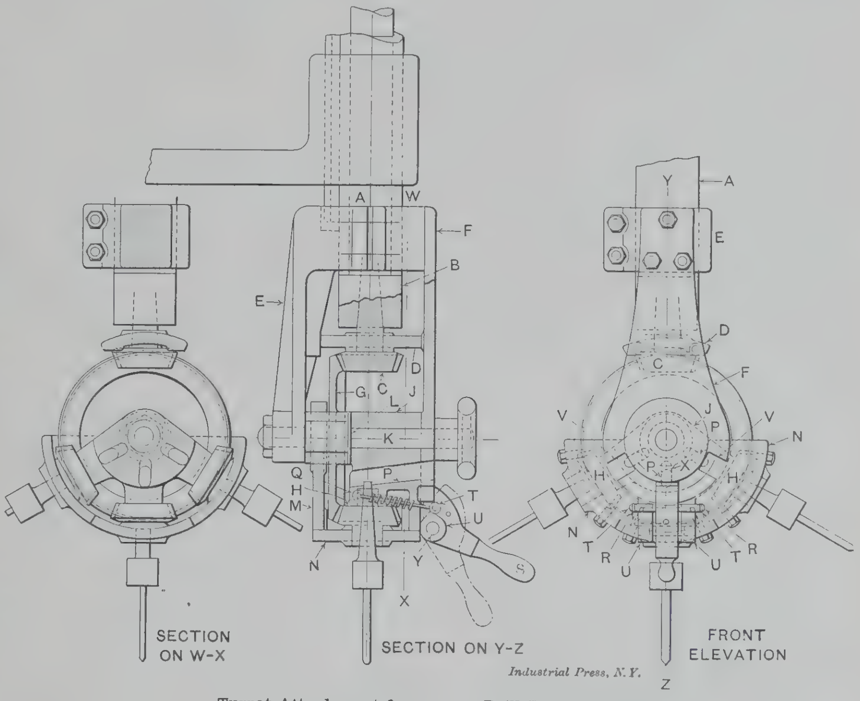
Table showing Relative Viscosity of Oils Tested.

TURRET ATTACHMENT FOR THE DRILL PRESS.

Editor MACHINERY:

In handling small jig work the length of time required for putting the piece in and out of the jig is often as great as that required for drilling the hole; or if it is thought advisable to keep the work in the jig from start to finish there is a great loss of time in changing the drills. There are several methods in use for eliminating this loss, such as the use of a chuck with collets which may be changed while the drill is running and also the use of multiple spindle drill presses. The interchangeable collet system is first rate for large drills with taper shanks, as the same collet will fit any drill; but for small work, requiring straight shank drills, it is necessary to have a collet for every size of drill in use or else to have several small chucks fitted with collets and, at best, some time is lost in changing and in selecting the right one.

The multiple spindle drill press is by far the best method if there is a sufficient amount of work to warrant it. There are, however, many cases where but little of this work is to be done and to meet such a case the drill press turret attachment here described was designed. This is attached to any drill press and, as designed, is of course suitable only for light work. It is illustrated in section and elevation in the drawings presented herewith.



Industrial Press, N. Y.

Turret Attachment for use on Drill Press.

Clamped fast to the drill press quill *A*, is the bracket *E* which carries a stud *K*. Running loose on this stud, between its head *L* and the hub of the casting *E*, is a bevel gear *G*, which is driven from the drill press spindle through the pinion *C*, and it in turn drives a series of bevel pinions *H*, *H*, *H*, whose hubs are bored with a taper hole to fit the shank of any small chuck or collet. Free on the stud *K*, is the turret *J*, which has three radial hubs that are bored to form a suitable inside bearing for the hubs of the pinions *H*; the outside bearings of these pinions being formed by the segment *N*, which is bolted on one side to a semi-circular flange of the turret *J* and on the other to a semi-circular plate *M*, running free on the hub of the gear *G*. This combination makes an extremely long and rigid bearing for the turret and is also an easy piece to manufacture as it is possible to turn and face the whole in a lathe even to the segment *N*. Plate *F*, being bolted at the top of the bracket *E*, forms an outside bearing for the stud as well as a convenient means of locking the turret in position.

The locking is accomplished as follows: The lugs *U U*, fastened to the turret, carry the locking pin and handle *S*. This pin passes through either one of the slots in the plate *F* and is held firmly in the notch in the turret by means of the two coiled springs *R*, *R*. When it is required to advance the turret, the handle is grasped and held down, after which the turret revolves automatically until the locking pin snaps into the next notch. This automatic revolving of the turret is due to the tendency of the gears to constantly cause it to turn on its own axis. Of course, after one cycle of operations is completed it must be turned back by hand to its original starting point. Should the tendency of the turret to revolve be too great it may be partially checked by means of a spiral spring or by some friction device arranged to hold in one direction only. The hand wheel, at the front, is threaded on the stud and can be tightened up as an extra locking device if extreme rigidity is required. This will probably not be needed except in cases of severe work or when great accuracy is required; if not needed it can be left just slack enough to make the turret rigid and yet turn easily. Pinion *C* is provided with a bearing *D*, bolted between *E* and *F*, which serves to line up the attachment on the drill press spindle and also forms a stop, keeping the pinion *H* from striking pinion *C*, should the turret be turned past the last notch.

P, *P*, *P*, are slots for driving the chuck out from its socket and can only be operated with the turret opposite the central slot in the plate *F*. It will be seen that the hand wheel will interfere with this, but the trouble can be remedied by cutting away a portion of the rim opposite the slot.

More than three spindles might be used by increasing the diameter of the gear *G* and crowding the pinions *H* nearer together; five or six spindles may be easily provided for without an excessive diameter of *G*, should the character of the work be such that they will not interfere with it. If the work is very light so that a sensitive drill is required, it may be obtained by substituting paper or leather faced wheels for the gears. In this case it would be necessary to provide an adjustment for the friction between the bevel wheels; and this could be easily done by making an up-and-down adjustment to the pinion *C*, on its spindle, and by making the inside bearings of pinions *H* part of the plate *N*, adjusting up and down by moving the plate in or out on dowel pins between the bolts.

Another change that might be desired is that of having all of the spindles stationary excepting the one in actual use. This could be accomplished in case of the friction drive, or in case of the gear drive if the gears are of a fine pitch, by making both the inside and outside bearing for the pinion *H* in one piece and eccentric with the holes in the plate *N* and turret, throwing this into gear by hand when any drill is wanted. A pinion put on the eccentric bushing below *N*, to mesh with a segment hanging from *E*, would throw the spindle in and out of gear as it passed by the segment. However, all of these extra refinements detract from the simplicity of the arrangement and are not advocated as necessary or desirable. FRED S. ENGLISH.

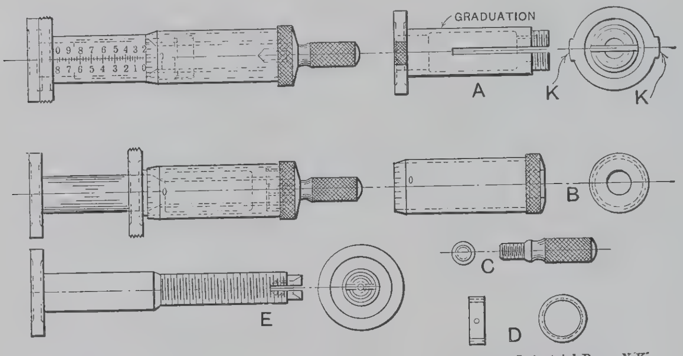
New London, Conn.

MICROMETER MEASURING INSTRUMENTS.

Editor MACHINERY:

The micrometer instruments here shown were built, in leisure hours, by Mr. A. L. Monrad, of this city, and with his consent I will illustrate and describe them, thinking that some of the readers of MACHINERY may wish to duplicate them for their own use.

Fig. 1 shows a form of micrometer that has proved very handy for measuring snap gages, and thicknesses, and can also be used as a small height gage to measure the distance from a shoulder to the base, as shown in Fig. 2. In measuring snap gages or thicknesses, the outside and inside of the measuring disks are used respectively. This instrument may also come in very handy when setting tools on the planer or shaper. As will be seen in the cut, there are two sets of graduations on the sleeve *A*, thus enabling the operator to tell at a glance what measurement is obtained from the outside or the inside of the measuring disks. Each of the disks is .10 inch thick so that the range of the micrometer is .80 and 1.00 inch for the outside and inside respectively. The details of the instrument are as follows:

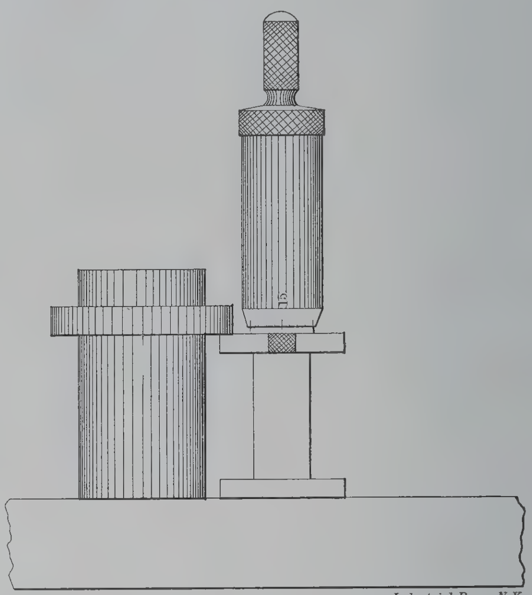


Industrial Press, N.Y.

Fig. 1. A Special Micrometer.

The sleeve *A* is composed of the inside measuring disk, the graduated sleeve, and the micrometer nut combined. On the disk are two projections, *KK*, which are knurled, thus providing a grip when operating the tool. The sleeve is threaded on the inside of one end, which acts as a micrometer nut, and the outside of this same end is threaded to receive the adjusting nut *D*. The sleeve has two slots, each placed 90 degrees from the graduations, and these provide for compensating for wear. The disk part is hardened by heating in a lead bath and is finished by grinding and lapping. The barrel *B* is the same as a regular micrometer barrel and is graduated in .025 divisions. Spindle *E* combines the outside disk and the micrometer screw, and the barrel *B* fits on its end, which is tapped out to receive the speeder *C*, which serves to hold the barrel in position. The thread is ¼ inch, 40 pitch, and the disk and unthreaded parts are hardened, ground and lapped. To adjust this instrument, loosen the speeder *C* and turn the barrel until the proper adjustment is obtained. Then lock the barrel by tightening the speeder again.

Fig. 3 shows an assembled view and the details of a micrometer caliper square which, if accurately made, is equal and ofttimes preferable to the vernier caliper now so generally used.

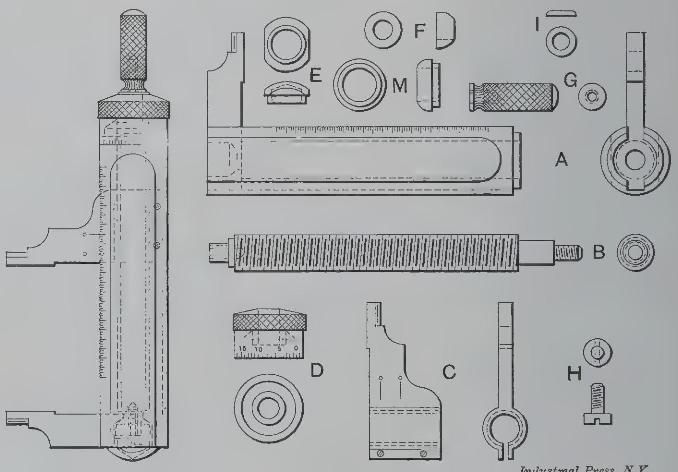


Industrial Press, N.Y.

Fig. 2. One of the Uses of the Special Micrometer.

One of its advantages over the vernier is that when the measurement is taken it can be readily discerned without straining the eyes and this instrument is as easy to manipulate as the regular micrometer.

In the details, part *A*, which is the main body of the instrument, is made of tool steel, the forward or jaw end being solid with the body. This end is hardened and the jaw ground and lapped. The body is bored out and two flats milled on the outside which lighten it up and make it neat in appearance. The jaw end is counterbored out with a 45-degree counterbore to form a bearing for the forward end of the micrometer screw. A slot, ⅛ inch in width, extends from the fixed jaw to the other end and in this slides the movable jaw *C*. There are 88 divisions along the side of this slot, each division being .025 inch apart, thus giving the tool a range of 2 inches for outside and 2.2 inches for inside measurements. The screw *B* is the most essential part of this tool, its construction requiring great accuracy. Its diameter is ⅜ inch and it is cut with a 20 pitch thread. On its forward end fits the cone *F*, which is hardened and ground, the round part acting as the forward bearing of the screw and fitting in the 45-degree counterbored hole in the body *A*. On its other end fits the graduated barrel *D* and also the speeder *G*.



Industrial Press, N.Y.

Fig. 3. Micrometer Caliper Square.

The barrel is graduated in fifty divisions, each division equaling .001 inch. On the inside of the barrel is a 45-degree bearing which rides on the cone *M*, the cone being held stationary on the end of the body. Thus it will be seen that both front and back ends of the micrometer screw are carried in cone bearings, which give a very small point of contact, thereby causing but little friction and preventing any danger of gumming up so as to run hard. The sliding jaw *C* is made of tool steel, hardened, ground and lapped, and combined with it is the micrometer nut which is drawn to a spring temper. This nut is split and adjusted by two screws to compensate for wear. On this jaw are the two zero marks that tell at a glance the outside or inside measurement taken. The screw and washer, marked *H* and *I*, go onto the end of the micrometer screw and take up the end play. To make a neat appearance, the cap *E* is placed in the forward counterbored hole, being held in place by a tight fit. The adjustment of the tool is accomplished by loosening the speeder *G* and turning the barrel on the screw, when the adjustment is made the speeder is again tightened down and the barrel locked.

The depth gage, shown in Fig. 4, has a ½ inch movement of the rod and may be used with rods of any desired length. These have small 45-degree-on-a-side grooves cut into them at intervals of ½ inch. A small coiled spring, marked *I*, gives the rod a constant downward pressure so that, when taking a measurement, the base of the tool is placed on the piece of work and the rod always finds the bottom of the hole; then, by tightening the knurled screw *F* the rod is clamped in position and the tool may be picked up and its measurement read from the dial. The graduations on this instrument are similar to those of the vernier caliper, only they are much plainer, as a half inch movement of the rod turns the dial one complete revolution. The figures on the dial denote tenths of an inch and those on the body of the tool, thousandths; each graduation on the dial is therefore equal to 10-1000, so that to show the depth of a hole to be .373 the dial would be revolved around so that the seventh division beyond the 3 mark would be near to 0 and then by looking from the 0 mark toward the left the third graduation on the body and one on the dial would be in line, thus denoting .373.

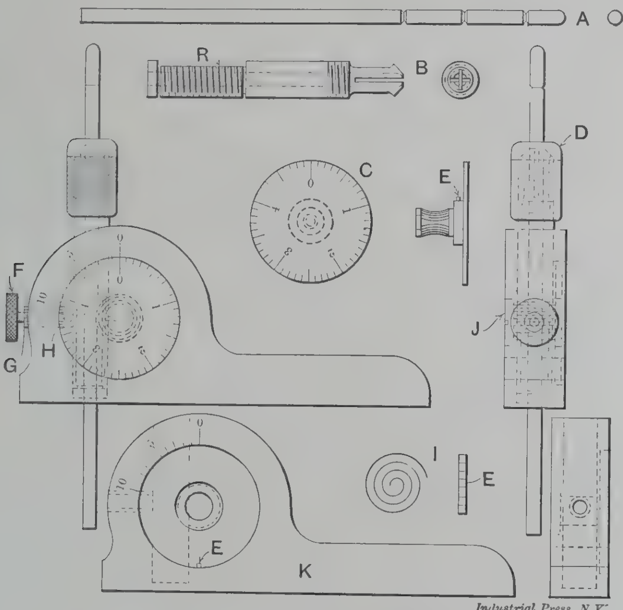


Fig. 4. A Vernier Depth Gage.

The most essential part of this tool is the threaded screw *B*, which acts as a rack, and the worm wheel, solid with the dial *C*. The upper end of the screw forms a split chuck which grips the measuring rods, while the part marked *R* is flatted off and against this portion bears the threaded sleeve *G*, which acts as a key to keep the screw in position. The sleeve is threaded, both inside and outside, and screws into the body of the tool, while the binding screw *F* fits into it and binds against a small piece of copper, marked *H*, which in turn holds the screw in position. The thread on *B* is .245 inch in diameter and is cut with a 40 pitch thread. The worm wheel which meshes into this screw is solid with the dial, as shown at *C*. It is .18 inch in diameter and requires great accuracy in cutting; it is not hobbed but the teeth, of which there are twenty, are milled with a circular cutter of the same diameter as the screw *B* plus .002 inch. The little studs, marked *EE*, on the dial and on the body *K*, hold the coiled spring in position. Very great accuracy must be attained when locating the holes, in *K*, that are to receive the screw and dial, *B* and *C*. The screw marked *J* fits into the dial, where it serves as a bearing and also holds the dial in position. The knurled cap *D* tightens the split chuck in order to hold the measuring rod firmly.

All of the tools that have been described require an accurately cut screw and, as very few lathes are capable of doing this, it may be well to illustrate an indicator for testing the accuracy of the lead screw and to explain the method in which it is used. This instrument is shown in Fig. 5, where it is applied to a test screw *K*. It consists of a body *A* on one end of which is a projection *L* to serve as the upper bearing for the pivoted lever *D*. This lever swings about a small steel pivot which can be adjusted by the screw *E*. The rear end of the lever is forked and between the prongs is passed a thread making a double turn about the pivot *F* that carries the pointer *J*. Any movement of this lever will, therefore, cause this pointer to revolve above the dial *C*. This dial has 20 divisions, each indicating one half thousandth of an inch movement of the front end of the lever, so that a total revolution of the pointer about the dial would indicate a movement of the front end of the lever of .02 inch. The screws *I*, *I*, *I*, serve to hold the dial in place on the body of the indicator while the spring *M* keeps the pointer normally at the zero mark. The indicator is held in the tool post by the arm *G*, which can be set at any angle and firmly clamped by the screw *H*.

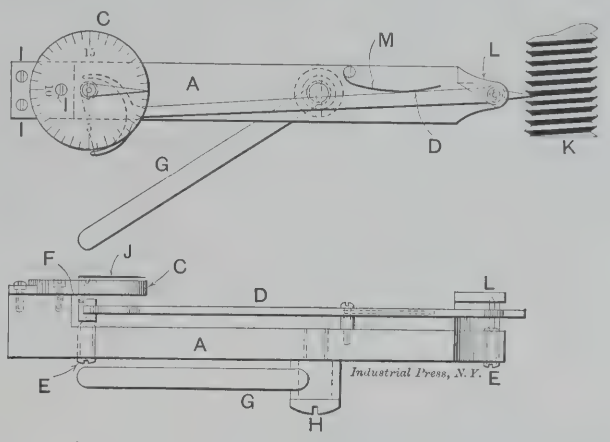


Fig. 5. Indicator for Testing Accuracy of Leadscrew.

To use the indicator, remove the screw from a micrometer which is known to be accurate and, with the aid of a brass bushing, chuck it in the lathe so that the threaded end will project. Now gear the lathe to cut 40 threads per inch and apply the indicator. When the lathe is started the point of the indicator follows along in the thread of the micrometer screw and any variation in the lead will be noted by a movement of the pointer over the dial. If, on the other hand, no movement takes place it is an indication that the pitch of the lead screw is correct. Jos. M. Stabel.

New Haven, Conn.

* * *

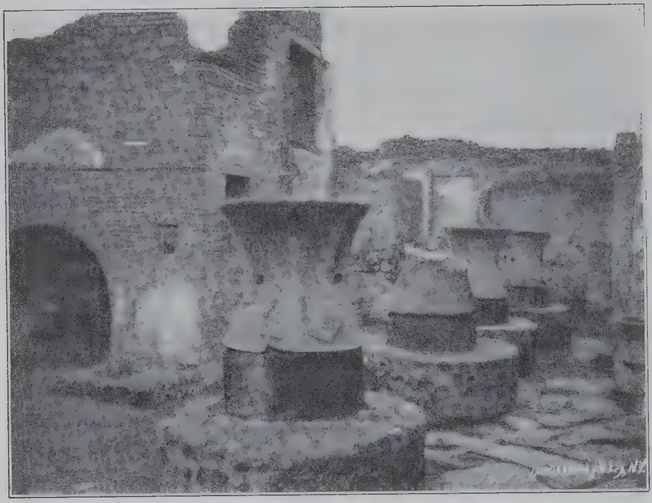
What is said to be a novelty in automatic cut-off engine construction, was built some time ago by the Erie Engine Works, and that is, right and left engines connected to the same crankshaft, cranks set at 90 degrees and flywheel in the center carrying two governors, one for each engine. Some trouble was anticipated from this arrangement as it was thought that there might be interference and racing developed by the non-concurrent action of the two governors, but it is claimed that none developed. The engine was built to the order of a customer who was located in a mountainous region, making the transportation of heavy parts difficult. He wanted a 300 horse power engine and by having it built as described it was more easily transported, quicker delivery was assured and the cost was 25 per cent. less. Another advantage is that if one engine breaks down, it can be disconnected and the other run independently, developing one-half the normal power and with perfect regulation.

NOTES OF TRAVEL—THE MILLS OF THE ANCIENTS.

Editor Machinery:

The grinding of grain for food by the Romans was evidently accomplished by the use of a pair of millstones—one stationary and the other rotating over it, in a way similar to what was our own common practice until recent years, comparatively speaking, before the roller milling process with its pairs of slightly-grooved, cylindrical chilled-iron rolls replaced the stones.

The millstones used by the Romans did not have flat surfaces rubbing together, however, as has been the practice of recent generations. Instead of these flat rubbing or grinding surfaces, they used stones conical in form, or approximately so. The illustration—a photograph taken in October, 1902, of one of the baker shops in excavated Pompeii—shows the forms of stones used. The lower stone has a conical top, and the other is hollowed out conically both top and bottom, so that either end will fit the nether stone. The outside is shaped to conform, in a general way, with the inner cones. The walls of the shell are thicker at the waist than at the ends of the upper stone; but the taper of the grinding surfaces does not differ materially from that of the outside. The inner stone reaches up to the middle of the upper one, and is only slightly more blunt than the external appearance of the latter might seem to indicate. The upper end is a hopper into which a considerable quantity of grain may be poured.



Pompeiian Bakery, showing the Millstones.

The sets of stones are placed very near together, so near that no four-footed animals of sufficient size to turn them would have room to walk around adjacent stones at the same time. Neither is there any space nearby where the beasts could have been placed and their power transmitted to the mills. The entire region is closely built up with houses. They might have been placed above on the second floor, but appearances are against it, and it is improbable. Neither are there any indications that the energy of either wind or water was applied. Although there are numerous water pipes in the city, up to the sizes of three inches or more in diameter, there were none of any but the smaller size near any of the grinding and baking shops.

History and present indications both seem to agree fully that man power was used for the grinding. It is recorded that slaves were utilized for the purpose. In the side of each upper stone, at the waist, there are cut two rectangular recesses, diametrically opposite each other. They are apparently for the insertion of a pair of short levers or arms for turning the stone.

The comparatively light weight of the rotating stone evidently made it necessary to give the conical form to the grinding surfaces in order to secure both sufficient pressure for crushing the grain and ample area of grinding surface, to pulverize it fine enough. And it is also possible that the sloping surfaces were necessary in order to feed the grain through between the stones; for with the slow speed that a man could give, there would be no appreciable centrifugal action, which is a factor in high-speed power-driven stones, acting to throw the grain out from the center.

The mouth of the oven shows indistinctly on the left side of the picture. Forrest R. Jones.

* * *

ITEMS OF MECHANICAL INTEREST.

NOVEL RATCHET MECHANISM—NEW MILLING CUTTER—ELECTRIC WORM-DRIVEN PUMP—REVERSING AN ENGINE—VARIABLE SPEED DEVICE—MERCURY VALVE VAPORIZER—NODON ELECTRIC VALVE.

The *Mechanical Review* says the practice of hardening steel dates back to the remotest antiquity. Homer, Pliny, and Lucretius refer to the hardness imparted to iron taken from the forge and plunged in water. The ancient Egyptians heated meteoric iron in the forge at a temperature somewhat below the melting point until it had absorbed enough carbon from the fuel to give it the requisite hardening properties, and then fashioned their weapons and tools from the metal thus obtained.

The *Mining Reporter* quotes a German photographic journal, the *Photographisches Wochenblatt*, as recommending the use of peroxide of hydrogen for giving greater intensity of color to blueprints. It will be remembered that a blueprint is not as intense on leaving the washing water as it is after some twenty-four hours' exposure to the air, an effect assigned to oxidation. To remedy this it is suggested that a few drops of peroxide of hydrogen be added to the water, to increase the rate of oxidation. The scheme is also useful when the paper is old and gives veiled prints. In case the sensitized paper has turned a greenish blue, it should be over printed until a decided image is visible. Then a little washing soda solution should be added to the washing water but it should be used sparingly. The washing should be repeated until the whites are clear, and then the prints should be given a final wash in water to which a little peroxide of hydrogen has been added.

Magnalium, developed by Ludwig Mach, is an alloy formed of varying proportions of magnesium and aluminum. Equal parts make a light, hard, tough metal susceptible of a high polish. It is silvery white and is not oxidized by exposure to the air, neither does ammonia nor sulphuric or acetic acid harm it. But it is affected by sea water from which we infer that salt is detrimental to it, making it unsuitable for cooking utensils. The alloy has a specific gravity of from 2 to 2.5, depending on the proportions of magnesium and aluminum. It can be rolled, hammered, forged, and worked generally in the same way as any malleable metal. A valuable property is that it can be cast in very thin shapes and that it fills a mold with absolute fidelity, thus making it particularly valuable for the reproduction of ornamental designs. The price of magnalium in Germany, where it is manufactured, is about the same as copper.

The oldest steamboat plying in waters in the vicinity of New York City is the "Norwich," built in New York in 1836. Her hull is of wood, constructed by Lawrence and Sneden. The engine is of the steeple type, and was constructed by Cunningham & Hall, New York. It has a cylinder 40 inches in diameter by 10 feet stroke. The original boiler was of iron, but this, of course, has been renewed as well as parts of the machinery and hull, causing the whole to be at the present time something like the "Dutchman's breeches." The boat was built for the New York and Norwich Steamboat Company and ran for a number of years on Long Island Sound. Afterwards it was used on the Hudson, on the New York and Rondout line. Since 1850 it has been employed for towing barges and for breaking the ice in the Hudson in the winter time, which occupation has given it the name of the "Ice King." The boat is a familiar object to those who take trips up the Hudson River.

In a pamphlet upon the prevention of loss by fire, Edward Atkinson calls attention to the numerous instances where spontaneous combustion has been caused by the use of lard or animal oils instead of mineral oils, and refers especially to the danger from waste soaked in animal oils. He says:

"The spontaneous combustion of waste has been one of the principal causes of loss by fire. This danger has been almost wholly removed from cotton factories by the substitution of the mineral or so-called paraffine (para affinis) oils for lubrication, in place of animal oils, the mineral oils having no affinity for oxygen. Investigation of oil has shown that 33 per cent. of mineral oil mixed with lard oil would overcome the tendency to spontaneous combustion; also 25 per cent. mixed with sperm. But these mixtures do not serve in machine tool work. Therefore, there is still a liability to the spontaneous combustion of waste used in wiping tools in machine shops where pure lard oil is used on the cutting tools. The liability to spontaneous combustion in woolen mills has been very much reduced since methods were discovered for scouring wool treated with mixed oils partly consisting of the mineral oils."

The Standard Roller Bearing Co., Philadelphia, have sent us the record of a large thrust bearing which at that time had been in use for something over two years (798 days). The bearing was of the same general type shown in the illustration, 8 inches inside diameter, 18 inches outside diameter, and with one-inch rollers and one-inch washers. The bearing operates at 125 revolutions, and sustains a constant load of 100,000 pounds. There are 78 rollers in the bearing, each roller, therefore, supporting 1,282 pounds. In the way of an interesting calculation it is estimated that the rollers average to make 16 revolutions per revolution of the bearing, or 2,000 turns per minute for each roller. The bearing operates 16 hours a day, making 120,000 revolutions for the bearing per day and 1,920,000 for each of the rollers. The total for the 798 days amounts to 95,760,000 rotations for the bearing and 1,532,160,000 for the rollers—a pretty good record under a pressure of 100,000 pounds, or 50 tons.

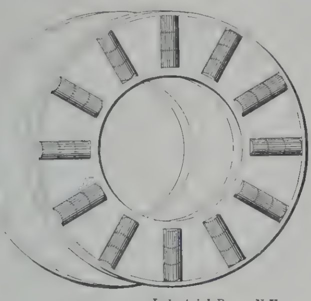

Industrial Press, N.Y.

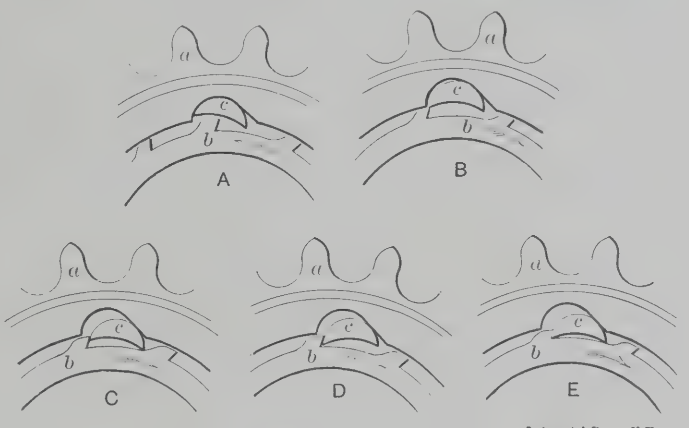
Fig. 1. Roller Thrust Bearing.

Theories have been advanced to account for the humming of telegraph and telephone wires, which are probably more satisfactory to the originators than the sound is to those who have to listen to it when the weather conditions are just right. The small boy is always firmly convinced that the wires are tingling with the messages sent; and some older people too. To stop the noise a device called the "anti-hum" is sometimes used, which is essentially the same in construction as a swivel in a chain. Rubber or some other elastic substance is placed between the bail and the pintle of the swivel and the current is conveyed around the rubber by a wire connection. The vibrations are absorbed by the rubber. The "anti-hum" is used where the wires come into depots and other offices where the din would be unbearable if something of the sort was not used. But it appears, from a statement made by a correspondent of *Science and Industry*, that the humming of telegraph and telephone wires can be prevented if the tie wires holding the line wire to the insulators are properly put up. The correspondent says that he has almost invariably found that if the ends of the tie wires are left to stand as they were after being twisted around the line wire, the line will hum; but if the tie wires are driven toward each other so as to tightly bind the line wire to the insulators there will be absolutely no humming.

Sir Samuel Wilks, writing to *Knowledge*, states that Fahrenheit's thermometer owed its beginnings to the invention of a thermometer by Newton, which was described in the Philosophical Transactions for 1701. Newton's instrument was a tube filled with linseed oil, and the starting-point of the scale was the temperature of the human body, which Newton called 12. It is worthy of notice that at this period, when numeration was based upon natural requirements, the duodecimal system was proposed for this, as it was in use for all other purposes. Newton accordingly divided the space between his datum and the freezing-point of water into 12 equal parts, and stated that the boiling-point of water would be about 30 of these degrees on the scale. Fahrenheit, when he began to work with Newton's thermometer, did not find the scale minute enough for his purposes. He therefore first doubled the number of degrees, making the scale number 24 instead of 12. Finding he could, by mixing ice and salt, obtain a temperature below freezing, Fahrenheit next adopted this for his starting-point and counted 24 degrees up to body heat, making the freezing-point 8 and calling boiling water 53. Later on he again divided his degrees into four. It will be seen that if the above figures are multiplied by four, the result is the thermometric scale called after him, which is still in use.—*Scientific American.*

NOVEL RATCHET MECHANISM.

An English concern is making a bicycle "free wheel" device which employs the simple and interesting ratchet shown diagrammatically in five positions at *A*, *B*, *C*, *D* and *E* in Fig. 2. The sprocket, which is the exterior part *a*, is recessed on its inner face for the reception of the crescent-shaped piece *c*, which acts as the pawl. The depth of the recess and the shape of the piece *c* are such that the teeth on *b* can pass freely when moving in the direction of the arrow at *A*, the piece *c* rocking in its recess to allow the teeth to pass. But movement of *b* in the opposite direction as at *B*, causes a tooth to at once catch the end of *c* which, sliding along the inclined face of its recess, gradually checks the movement, and at the same time moves into full engagement with the tooth in *b*. The successive positions are indicated at *C*, *D* and *E*. No spring is necessary for the operation of the pawl, and "free wheel" movement is resisted with very little friction, being only that of the pawl *c* riding over the tops of the teeth in *b*, and practically of no account.



Industrial Press, N.Y.

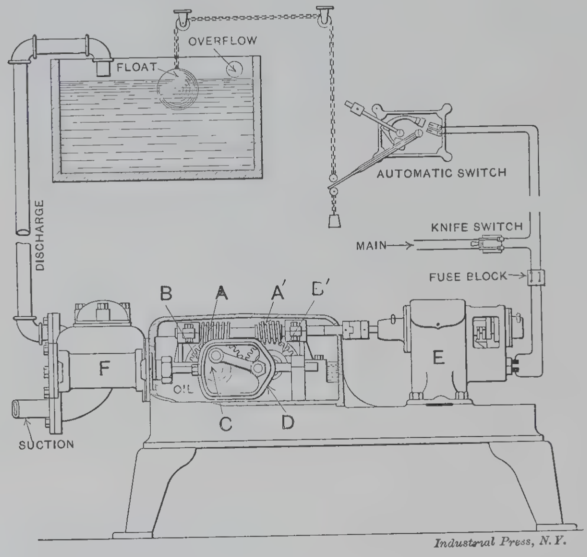
Fig. 2. An English Ratchet Mechanism.

A NEW TYPE OF MILLING CUTTER.

A milling cutter for surfacing is the subject of a patent recently issued to the Krupps, of Essen, Germany. The flutes are made helical, as in ordinary practice, but in addition a thread of moderate pitch is cut over the surface of the teeth, making the cutter practically a hob with helical flutes. The teeth are rounded at the top, similar to a Whitworth thread section. The evident object sought is to make a surfacing cutter in which the cutting action shall more resemble that of a diamond-point lathe tool than a broad-nose finishing tool, than it does with the ordinary cutter. It is stated that experiments have shown that this scheme greatly reduces the power required for the cut and at the same time increases the efficiency of the cutter, especially when taking heavy cuts. If this is true it quite evidently demonstrates that provision in a milling cutter which permits the chips to curl easily is of considerable importance—more in fact than cutting the chips into larger pieces. It has always been a matter for reproach that the milling cutter divides the metal into so many parts that much power is wasted; but if a simple change of shape, which involves many more teeth, actually effects a reduction of nearly fifty per cent. of the power required, as it is said to do, it shows that the action of milling cutters has been somewhat misunderstood.

ELECTRIC MOTOR WORM-DRIVEN PUMP.

An excellent example of compact machine design in which rapid rotary motion is efficiently converted into comparatively slow reciprocating motion by means of worm gearing, is that of an electric pump shown in Fig. 3. It consists of the motor *E*, mounted on a base with a duplex pump, which drives the latter by means of double worm gearing and cranks. The combination of right- and left-hand worms, *A* and *A′*, driving two wormwheels, *B* and *B′*, which mesh together and thereby balance the thrust of the worms, is, of course, not new, but the principle is an interesting one, as is this particular application. The cranks are mounted on the shaft of the wormwheel *B*. One-half the power of the motor (less friction) is transmitted to the wormwheel *B* through the worm meshing with it; the other one-half is transmitted to it by the meshing wormwheel *B′*. By the use of the yoked extended piston rod *D* and short connecting-rod, the combination is made unusually compact. As stated, the pump is duplex, the other yoked piston rod and crank being located on the opposite side from that shown in the engraving.

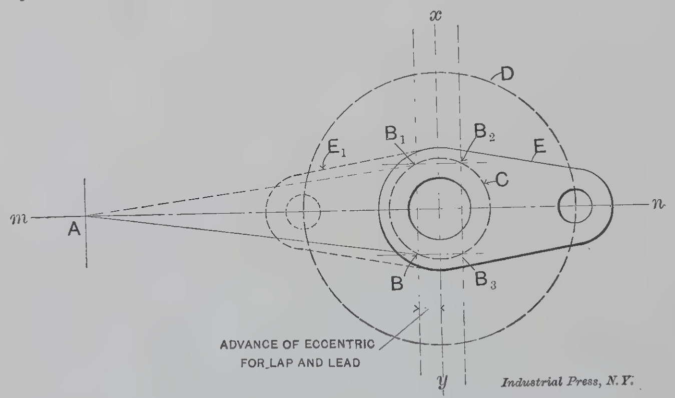


Industrial Press, N.Y.

Fig. 3. Electrically-operated Worm-driven Pump.

REVERSING A SINGLE-VALVE ENGINE.

An item in a contemporary gives directions for reversing the motion of a single-valve engine as follows: "Turn the engine until it is on one or the other of the exact dead centers. Then mark the valve stem close to the stuffing box. Then turn the engine over until it reaches the other exact dead center; unfasten the eccentric and turn again until the mark comes to the first position. Refasten the eccentric. By using great accuracy the valve and lead will not be changed."



Industrial Press, N.Y.

Fig. 4. Diagram Illustrating the Method of Reversing a Single Valve Engine

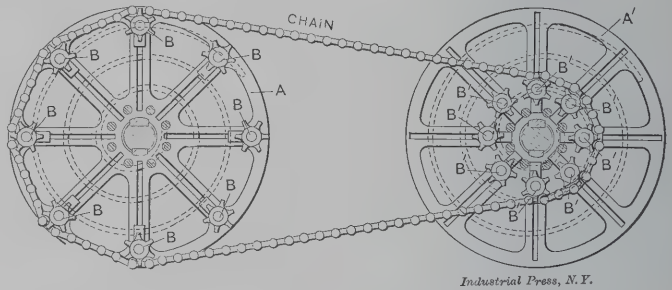
Unfortunately this information, put so concisely, is not correct. The accompanying sketch shows diagrammatically what the condition would be after following the directions. *E* is the crank on one dead center. The center of the eccentric for an ordinary slide valve direct-connected engine, would then be at *B* on the dotted eccentric circle line, *C*. The eccentric rod is indicated by the full line *AB*. Now when the crank is placed on the other dead center as shown by the dotted lines E_1, the center of the eccentric will be shifted just 180 degrees from its former position, or to B_2. Then loosening the eccentric and turning it on the shaft until the mark on the valve stem again shows fair at the face of the stuffing-box, as directed above, might result in placing the eccentric in either of the positions indicated by *B* and B_1. In neither of these positions will the valve be properly set. Instead of being advanced from the 90-degree line *x y* an amount equaling the lap and lead, it would be set back of the 90-degree line just that amount. Of course the valve would *not* be properly set if set in this position.

Following is a short reliable rule for reversing a single valve engine: Put the crank on either dead center *and let it stay there until through.* Scribe a line on the valve stem next to the stuffing-box. Loosen the eccentric and turn it on the shaft until the mark on the valve stem is again even with the face of the stuffing-box. Tighten the eccentric, and the engine is reversed.

It makes no difference in which direction the eccentric is turned on the shaft, but the shortest distance with an ordinary slide valve engine is away from the crank-pin, as is plainly shown on the diagram. The position of eccentric center is shown at *B* and to reverse the engine, it should be at B_1, the crank remaining in its position. The eccentric rod would then occupy the position shown by the dotted lines AB_1.

VARIABLE SPEED DEVICE.

In Fig. 5 is shown the essential principle of a British variable speed gear invented by W. N. Dumaresq and being introduced by the British Simplex Gear Co., Kensington, England. The limit of speed ratio obtainable with the device of the standard type as shown, is 4 to 1; that is, the speed of the driven shaft may be reduced to one-half that of the driving shaft, or it may be increased to two times the speed of the driving shaft. With a third drum or sprocket the speed ratio limits are as 20 to 1. The wheels *A* and *A′* are each made up of two disks or plates mounted on a shaft and carrying between them small toothed pinions, *B B B*, etc., and *B′ B′ B′*, etc., which are mounted on roller clutches. The bearings for the pinions are arranged to move radially in the slots shown in the plates, so that the diameter around which the chain must wrap, may be lengthened or shortened at will. Of course if the pinions of one wheel or drum are moved radially outward, those of the mating drum must be moved inwardly, and *vice versa.* The clutches, on which the small pinions are mounted, lock the pinions from moving in the direction of the pull of the chain, but offer no resistance to movement in the reverse direction. So it is evident that for such positions of the pinions that the chord lengths between adjacent pinions are not multiples of the chain link lengths, there is a constant forward turning movement of the pinions on their clutches to permit the chain engaging the teeth properly. Otherwise the chain would necessarily mount the tops of the sprocket teeth, except where the chord lengths were exact multiples of the chain link lengths. The sum of the matter is that the inventor has produced a variable sprocket wheel with provision for automatically adjusting itself to the fractional divisions of sprocket tooth space that occur when the diameter is changed.



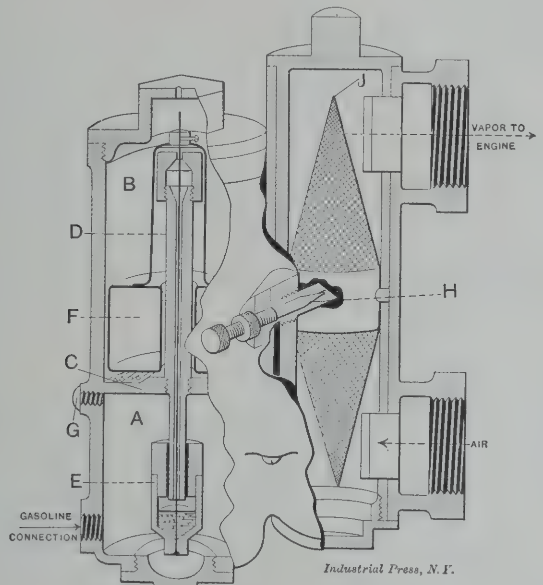
Industrial Press, N.Y.

Fig. 5. Chain-driven Variable Speed Device.

The pinions are moved radially by means of two scroll plates for each sprocket, the spiral slots of which engage the bearings of the pinions and move them in the same manner as the jaws of a scroll chuck are operated. The manner in which the scroll plates are turned, to effect changes in diameter of driving and driven gears, is not shown. It is accomplished by the simultaneous moving in or out of two flat racks lying in slots cut in the sprocket shafts. These racks have teeth cut across their faces at an acute angle instead of at a right angle, as ordinarily, and these teeth engage in similarly cut teeth in the bosses of the scroll plates, these to all intents and purposes being internal helical gears. The simultaneous longitudinal movement of the racks is effected by means of a screw engaging with a yoke connecting the two racks. The teeth of the racks being cut in opposite directions as are also those of the internal helical gears, the common movement of the racks turns one scroll plate in one direction and the other in the opposite direction, thus enlarging one sprocket diameter and contracting the other. The chain and its sprocket run in oil.

MERCURY VALVE VAPORIZER.

One of the drawbacks to the use of the gasoline engine for either stationary or automobile use is the fire danger that comes from the gasoline reservoir being located above the burner, so as to obtain the reliability of gravity feed. With the best mechanical valves and lever floats, as ordinarily constructed, there is always the danger of leakage, and even a leak of very small extent may suffice to flood the vaporizer and cylinder and cause a disaster which may endanger human life. So many accidents of this character have occurred that pumps are used to some extent to supply the gasoline to the vaporizer so as to avoid the danger accompanying leaky valves.



Industrial Press, N. Y.

Fig. 6. The Mercury Valve Vaporizer.

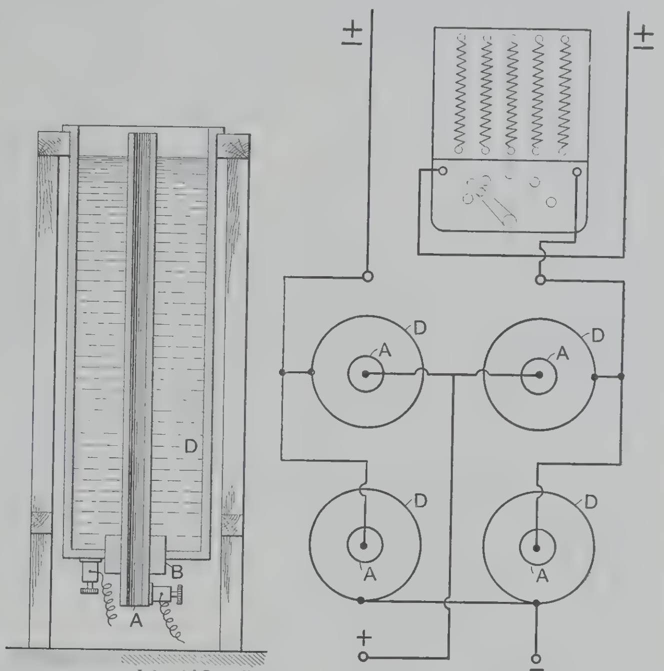
In the cut, Fig. 6, is shown a mercury valve vaporizer invented by A. W. Olds, Hartford, Conn., which is designed to afford all the benefits of gravity feed without the danger of leakage. *A* is the supply chamber separated from a float chamber *B* by a horizontal chamber. A tube *D* connects the two. At the lower end of the tube is a cup *E* containing a small quantity of mercury. This cup is supported by the float *F*, being connected to it by means of a bail and the slender wire rod passing down through the tube to the cup. Gasoline flows into the chamber *A* and because of its hydrostatic head it rises slowly but freely up through the small hole in the tube into the float chamber *B* until the chamber is partially filled and float raised sufficiently to seal the lower mouth of the tube with the mercury in the cup *E*. The pressure of the gasoline then forces a column of mercury up into the tube to such a height as will just balance the head. When this condition is reached no more gasoline can enter the float chamber until that already in it has been reduced by being drawn through the needle valve *H* into the vaporizer chamber *J*, by the slight vacuum caused by the operation of the engine. As the supply of gasoline in the float chamber lowers, the mercury cup lowers and uncovers the bottom of the tube, allowing more gasoline to bubble up through the column of mercury until it is again shut off by the float rising in the chamber.

The inventor says that every action of the vaporizer is sure, as it depends upon the omnipresent force of gravity, and of course the mercury cup always acts as a perfect valve in which wear takes no part, thus making leakage impossible.

THE NODON ELECTRIC VALVE.

A comparatively recent development in electrical engineering is the use of static rectifiers for converting alternating current into direct current without the use of moving machinery. The method generally followed where it is desirable to convert an alternating current into direct current, is to use a rotary converter. This consists of an alternating current motor mounted on the same shaft with a direct current dynamo. The power developed by the motor is converted into electric current at whatever voltage may be required. With the Hewitt and Nodon static rectifiers, moving machinery is not required. They act in the same manner as a check valve in a water pipe, which allows a liquid to be forced in one direction, but prevents flowing in the opposite direction. The same occurs with the electric valve; the impulses in one direction pass without interference, but those in the opposite direction are shut off.

The accompanying cuts from the *Electrician*, Figs. 7 and 8, show the Nodon electric valve in section and also show by diagram how the impulses in both directions are converted into direct current flowing from one common wire. This latter is, of course, highly desirable, otherwise the capacity of the central station generator would be reduced exactly one-half.



Industrial Press, N.Y. *Industrial Press, N.Y.*

Figs. 7 and 8. The Nodon Electric Valve.

The Nodon rectifier, which is a development of the apparatus discovered by Pollak and Graetz, is extremely simple in design, and consists merely of a hollow cylinder *A*, Fig. 7, of zinc and aluminum alloy, immersed in a solution of ammonium phosphate. A containing vessel, *D*, of iron, forms the other electrode, from which *A* is insulated by the rubber plug *B*.

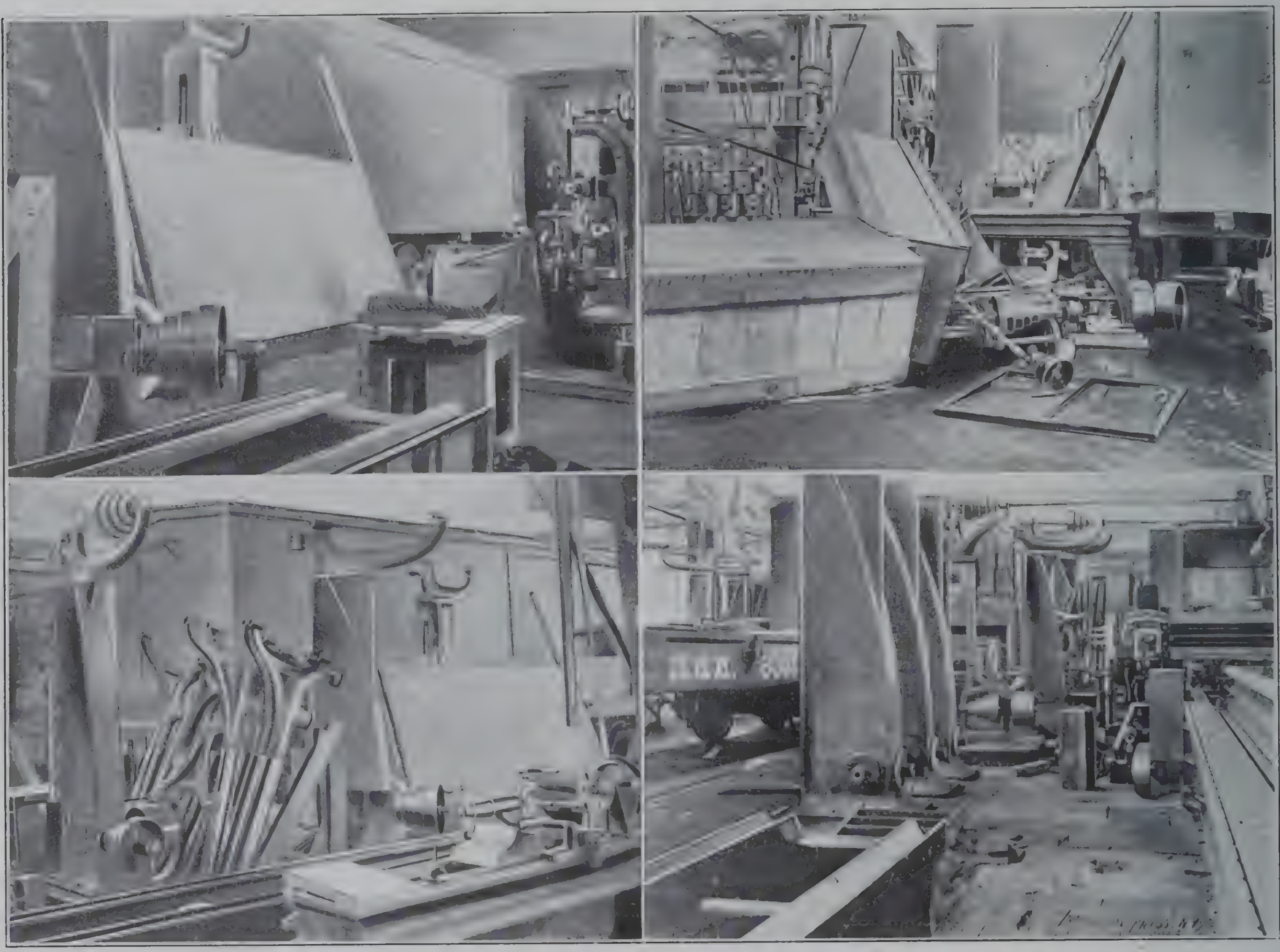
On starting the "valve," as it is called, it merely acts as a liquid resistance, and does not choke back one-half of each alternation. This, however, only lasts for a very brief time, and after a few minutes a film commences to form on the surface of the aluminum electrode. It is this film which possesses such valuable properties and permits current to pass in one direction only—i. e., from *D* to *A*. Obviously, the fact that only half the energy can be utilized is a disadvantage, but it is possible to adopt the scheme of connections shown in Fig. 8, and by using four cells, convert all, or nearly all, the alternating current into continuous current. This grouping is known as the Leo Graetz method; by following out the connections it may be seen that both semi-phases are utilized.

When used in conjunction with polyphase systems, the matter becomes rather more complicated, and it is necessary to employ a number of cells or valves equal to twice the number of wires used in distribution; for instance, six would be required on a three-wire three-phase system. Each cell may be used for rectifying current at from 50 to 140 volts, but when the voltage exceeds the latter figure, two or more cells must be connected in series, allowing 140 volts, as a maximum for each cell.

RAILROAD WRECK IN A MACHINE SHOP.

A peculiar accident occurred at the shops of the Prentice Bros. Co., Worcester, Mass., last February as the result of a train of runaway cars, and an interesting group of photographs of the resulting wreck is reproduced herewith. More than $15,000 worth of machines were damaged or ruined, but fortunately no one was seriously injured, although Supt. Harry V. Prentice and Foreman Smith barely escaped with their lives, the former receiving a bruised wrist.

The line of the New York, New Haven and Hartford Railroad runs near the Prentice shops, from which a siding extends into the main shop. The railroad is on an embankment above the level of the shop floor, making necessary a 20 per cent. grade for the siding. The accident happened early in the morning. A switch engine had just pulled two loaded cars from the shop and placed them on a siding, when seven other cars near the main line started down the incline of the shop track. It was supposed that the brakes would hold the cars, but the track was wet and they did not. When the cars started the conductor and brakemen jumped for the brakes to set them up tighter, but with no effect and were obliged to jump from the train to save themselves. The cars gained headway down the grade, and the leader, a flat car, crashed through the shop door, splintering woodwork and glass. There were 12 engine lathes and 11 upright drills standing in the shop to be shipped on these very cars. These were scattered and broken up to a greater or less extent—mostly greater—and a sensitive drill which had just been inspected was caught under the trucks of the flat car and made a subject for the scrap heap and carried over 100 feet under the cars. A pile of finished castings, weighing perhaps 75 tons, finally stopped the avalanche, but not until one of the traveling cranes had taken revenge by doing a little angling with the crane hook on its own account. The crane was at this end of the shop with its hook suspended several feet above the floor. The flat car passed under it, but the next, a box car, was fairly caught and its roof lifted off in a neat and workmanlike manner. If it had not been for the pile of castings mentioned nothing would have prevented the cars from going clear through the works and doing more extensive damage. The railroad made prompt settlement for the loss; but unfortunately the tools that were injured were on a rush order, and the delay, of course, inconvenienced the customers.



Views of the Railroad Wreck in the Machine Shop of the Prentice Bros. Co.

* * *

TO KEEP TAB ON THE ENGINEER.

A company has been organized in Milwaukee to finance an invention which the inventor claims will prevent many of the wrecks and accidents which now prove so disastrous. The instrument is styled the "railway chronograph." The machine is a small affair, but does wonderful work. An iron box about twelve inches square and three inches thick contains the instrument, which is devised to keep a record of the locomotive to which it is attached, and its engineer. The mechanism is such that it records on a tape every blast of the whistle, with its exact time and place, the speed of the train at every moment of time, the time and place any accident occurs, the speed approaching, the arrival, the delay and the departure from any station, the number of miles and amount of time consumed in switching at any station, when and where the airbrake is applied, how long the engineer is on duty any and every trip, just where the locomotive was at that moment and what it was doing at the time, and how much steam was wasted through the escape valve. The device is entirely automatic and simple to a degree. It is attached to the engine just in front of the cab and over the boiler. Mr. Sedgwick, the inventor, began his career as a telegraph operator; later he became a Methodist minister, then a professor in several colleges as a teacher of railway and mechanical engineering. He says that, despite its simplicity, the machine required ten of his best years for its perfection.

The inventor has apparently neglected one very important and desirable feature in his device, and that is means for recording the times and places where the engineer waves his hand to sundry red-headed girls along the line. That he has not provided for this vitally important record shows clearly to us that he is not thoroughly posted on all the details of railroading.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

A subscriber asks us for information regarding the Stubbs standard screw thread. What is the form of thread and number of threads per inch for the various sizes? We have been unable to secure any data upon this subject and if any of our readers can give us the required information we should be pleased to receive it.

19. O. P. and W. C.—Can you inform us how the covering or jacket is put on a steel shaft? We use a machine steel shaft about 11-16-inch diameter with a brass jacket 5-32-inch thick, making the outside diameter one inch. The length we use is about 6 feet; also larger sizes 12 feet long.

A.—We submit this to the readers for reply.—Editor.

20. W. H. S.—Will you kindly inform me what is the best lubricant to use in turning copper, such as for commutators and similar electrical work?

A.—You will find the use of sweet milk to give excellent results.

21. Inquirer.—Can you give me information as to the speed at which sewing machines operated by power in factories are arranged to run? I understand that they frequently make as many as 6,500 revolutions a minute.

A.—The Singer Manufacturing Company inform us that while machines for exhibition purposes may make as high as 6,500 revolutions a minute, the majority of sewing machines run by power in factories to-day operate at 2,000 to 2,500, although there are some high-speed machines used on special work under certain conditions that are run at 4,000 stitches per minute.

22. E. I.—Having seen numerous discussions of the theoretical advantages possessed by each of the two systems of gearing—involute and epicycloidal—I would like to inquire which system is the better fitted for general shop use, considered from a practical, rather than a theoretical, point of view?

A.—The involute system is without doubt the best suited for all purposes and is the only system that is used to any very great extent at the present time. One of its advantages is that, while with the epicycloidal system it is necessary to have the center distances exact, with the involute system the center distances may vary quite a considerable amount from the exact dimension and the gears will yet run in a satisfactory manner. One of the greatest points in favor of the involute system, however, is the much smaller number of cutters that are required than are necessary for the epicycloidal system. To cut all numbers of teeth from 12 to rack, of a given pitch, in the involute system, but eight cutters are required; while for the same range with the epicycloidal system it would be necessary to have a set of twenty-four cutters.

23. G. S.—Will you please inform me what is used for filling up cracks and blow holes in castings in order to smooth up the surface before painting? I wish to produce a good, smooth finish without an unreasonable expenditure of time and labor.

A.—For filling large cracks or blow holes there is a preparation called "adamant" cement. This is a metallic compound and comes in the form of a fine dry powder. For use it is mixed with water to the consistency of a thick paste and applied to the cavities with a putty knife. In a few hours it becomes as solid as the iron and is insoluble in either water or oil.

After filling the large holes with the cement the casting should be given a good heavy coat of iron "filler," which is a paint product containing paint pigments mixed with varnish liquids most suited to produce a body over the surface of the casting. This is applied with a paint brush and dries in about an hour. (The exact constituents of both the filler and cement are "trade secrets" which are not available for publication.) When the filler has become thoroughly dry it is "rubbed down" with sand paper, rotten, or pumice stone and then the machine is painted with ordinary machine paint.

24. O. L. F.—In reference to your article on electric welding in the last number, I would like to inquire why it is that in welding tubing, or in fact cylinders or rings of any description, the current always flows through the edges of the piece being welded. Why should not at least part of the current flow around through the back of the tube or ring and so make electrical connections between the clamps or contact points in that way?

A.—We referred this inquiry to Mr. W. L. Gorton of the Standard Welding Company, who replies as follows: This question regarding the action of the current in electric welding is a common one. The best answer the writer can give is to refer your correspondent to Ohm's law. The reason why the current does not pass around the outside of the tube in any very large amount is that the resistance around the tube is so much greater than across the joint that the current flows in the lines of the least resistance and takes the shortest path. The same thing is true of any circular form that is welded. In the case of the tube, however, there is another element which is an important one. If the current should attempt to take the long passage around the circumference of the tube when the weld is started, there would be set up by this action a very strong magnetic influence in the tube. This magnetic influence tends to increase the resistance of the circuit as well as the counter electro-motive force, and for that reason, principally, in tube welding, the leakage of current around the tube is checked very considerably.

25. W. H. W.—Will you kindly explain the difference between the centrifugal and the inertia form of steam engine governor?

A.—The centrifugal governor, of which the "fly-ball" governor is the most common example, is one in which two heavy balls are caused to rotate around the governor shaft by means of a belt driven by the crankshaft. As the engine increases in speed, and the balls revolve faster, centrifugal force causes them to fly out from the governor shaft and in so doing they operate a system of levers which close the throttle and thereby reduce the speed of the engine. If the engine is of the automatic cut-off type, the action of the levers is to hasten the point of cut-off and thereby slow down the engine to normal speed. When the tendency of the engine is to run slower than the desired speed the centrifugal force acting on the governor balls is lessened, with the result that they approach nearer to the governor shaft and operate the levers in a direction suited to open the throttle wider, or to retard the point of cut-off, so that the speed of the engine will increase. The flywheel governor, which is used largely on high-speed electrical engines, is also a type of centrifugal governor. In this case a pair of weights are pivoted within the flywheel and as the speed of the engine increases they tend to fly out from the shaft and thereby move the eccentric either around or across the shaft, or both, as the case may be, thereby changing the point of cut-off and decreasing the speed of the engine. When the speed of the engine falls below normal the weights tend to draw in toward the shaft and the movement of the eccentric which this produces causes the engine to increase in speed.

In the inertia governor, of which the Rites is the best known example, we have a weight revolving with the governor shaft and normally at the same rate. If, however, the rotation of the shaft is accelerated or retarded, the weight will continue to rotate at its normal speed and a relative motion is produced between the shaft and the weight and this motion, acting upon the eccentric or cut-off mechanism, restores the engine to its regular rate of speed. If the weight be pivoted about the center of the governor shaft, it will be seen that it will not be affected by centrifugal force but will operate only by the effect of its inertia. It may, however, be pivoted outside the center of the shaft and will then be affected to a greater or less extent by centrifugal force. By placing the pivot behind or ahead of the weight, relative to its direction of rotation, the action of the two forces may be made to assist or oppose each other, and the action of the governor may in this way be made more sensitive or more sluggish, as the case may require.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

THE OESTERLEIN MILLING MACHINE WITH SPUR GEAR FEED MECHANISM.

The half-tone, Fig. 1, presented herewith, illustrates the new No. 24 milling machine that has just been placed on the market by the Oesterlein Machine Co., Cincinnati, Ohio. The most noticeable improvement that has been made upon this machine is the use of an all gear feed mechanism, the details of which will be clearly seen by reference to Fig. 2. In this construction spur gears are used for transmitting power from the spindle to the feed box, a duty which is ordinarily performed by bevel gears, chains, or worm gearing. These gears are of steel, cut from the solid, and are so designed that the belt on the machine cone will give way before any part of the feed mechanism breaks. This feed is a positive gear drive and consists principally of two gear boxes, an upper one which takes the power from the spindle and transmits it to the lower box, the upper box containing a sliding gear on the spindle operated by a lever to make one change of speed. The lower box contains a cone of gears, and a sliding gear by means of which the different gears may be engaged; the change is made instantly by engaging the sliding gear to any of the cone gears while the machine is running. An index plate giving the amount of travel for each gear is affixed to the feed box, so the operator can readily see what feed he is using. The feed changes are .004, .006, .008, .011, .014, .017, .020, .029, .039, .052, .066, .091 inch to one revolution of the spindle. All gears are covered by protecting guards.

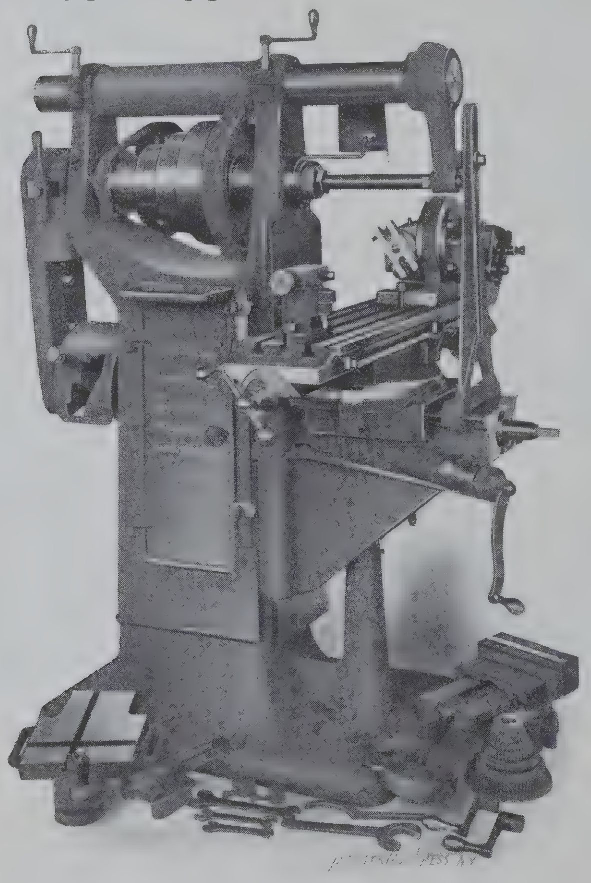


Fig. 1. Oesterlein No. 24 Milling Machine.

All screws have graduations to .001 inch. The gears in the saddle are oiled through holes in the back of the swivel. Bearings and clutches are oiled through the center table slot, by moving the table clear to the end, the oil holes coming in line with the bearings. The spindle has a hole its entire length with No. 10 B. & S. taper. The front end is threaded to allow standard cutters to be put on, and this thread is covered by a nut when not in use. The front journal is tapered and is provided with the lock nut to compensate for wear.

The cone has four steps for 3 inch belt, the diameters being 12 inches, 9¾ inches, 7½ inches, 5½ inches. The back gear ratio is 6.3 which will give, with the countershaft running 100 revolutions, a speed of 228, 130, 76, 43, 36, 20, 12, 7 revolutions per minute. The table is 40 inches long; 9 inches wide, has 3 T slots ⅝ inch wide. It has a quick return of 3 to 1 and can be operated from either end. It has screw feed, and screw has adjusting nut to compensate for wear. The table is engaged to the feed by means of a clutch on the screw, which clutch does not ride on the screw directly, but slides on a sleeve so as not to injure the screw. The whole is a very simple and positive movement without any springs, and stops the table every time within a thousandth of an inch. The table has an automatic longitudinal feed of 24 inches, automatic cross feed 7½ inches, and can be lowered 18 inches from center of spindle.

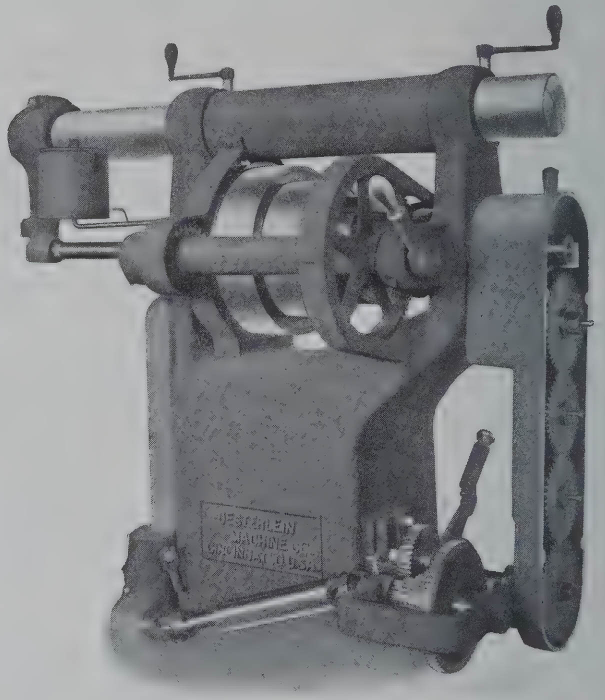


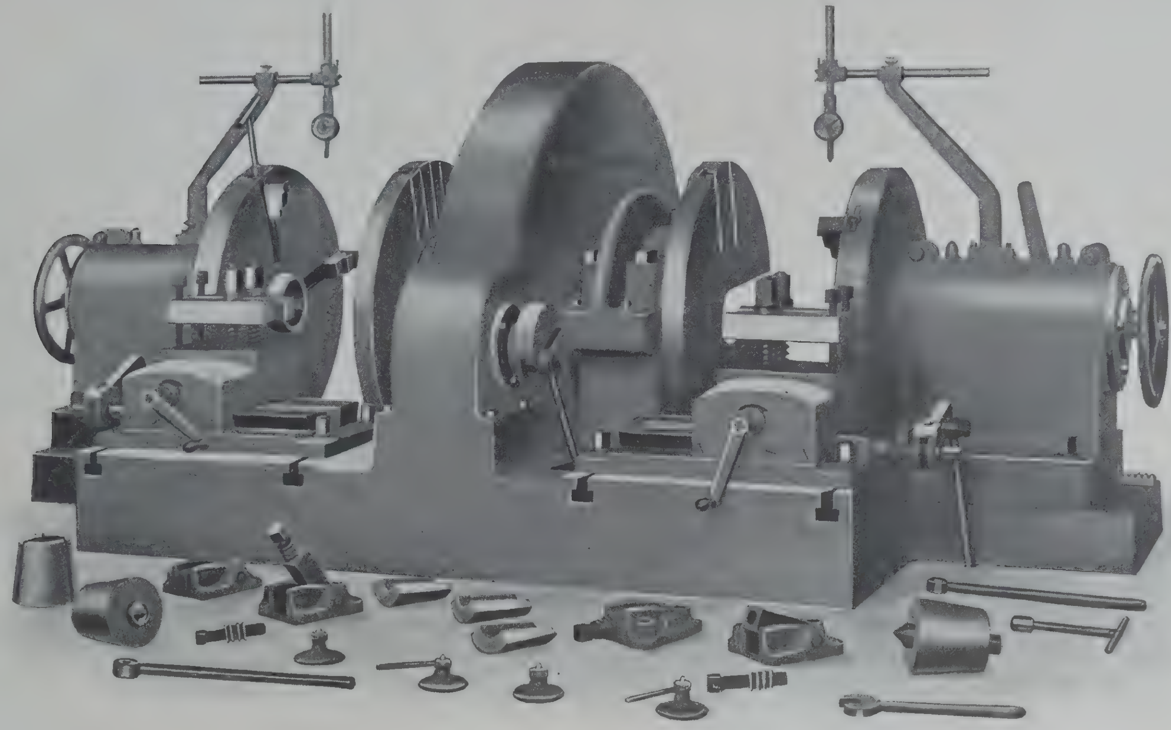
Fig. 2. Spur Gear Feed Mechanism of Oesterlein Milling Machine.

The back center is adjustable and can be lowered and raised by means of a worm and rack; the great advantage of this is the certainty that it cannot lower when once set, as is the case with centers that are merely held by friction. The dividing head is of new design, its construction allowing closer adjustment of the spindle than the old style. It is arranged to swing way round so that the work may be operated upon from either side of the head. The spindle may be clamped tight so as to release the indexing pin from all strain. It has a No. 10 B. & S. taper and swings 11 inches in diameter and 19 inches between centers. The total weight of the machine is about 2,400 pounds.

HEAVY STEEL-TIRED CARWHEEL LATHE.

The Pond branch of the Niles-Bement-Pond Co. have recently built for the Pennsylvania R. R. a number of 42-inch carwheel lathes of extraordinarily heavy design and powerful drive. A number of mechanical features make the machine an interesting tool, and the daily output of turned tires alone is calculated to attract much attention, being, we believe, unparalleled by any other carwheel lathe made for this class of work.

With the ordinary carwheel lathe made to turn wheels mounted on their axles, there is always a serious lack of stiffness of the wheels when under a heavy cut. The driving force must be applied to the sides of the wheels, in the case of those having solid center disks, and the wheels are mounted on comparatively slender axles which are only supported at the ends by pointed centers; all this contributes to lack of rigidity. There is also a tendency to force the wheels out of truth sideways at points between the driving dogs. In this lathe, self-centering chucks grasp the axle journals and chuck jaws engage the inner periphery of the tires where they overhang the wheel centers. The wheels are driven by dogs attached to the centrally driven plates mounted on the work spindle. Power to drive the wheels is not transmitted through the outside chucks, the function of these being only to add stiffness and support to the wheels so that they may be held firmly to the heaviest cuts.


Lathe for Turning Steel-tired Carwheels.

The drive is transmitted to the work spindle by means of a heavy worm meshing with a large wormwheel mounted in the center. The spindle and wormwheel are, of course, slotted to the center on one side to allow the wheels and axle to be placed in position from the side. The gap in the wormwheel is closed by a section bolted in place. The worm driving the wormwheel is in turn worm-driven, and in some cases an electric motor is attached directly to the second worm shaft. The main driving worm and the second wormwheel and worm are located in a pit beneath the floor so that the actual floor space taken up by this tool is about the same as for lighter lathes of the same class.

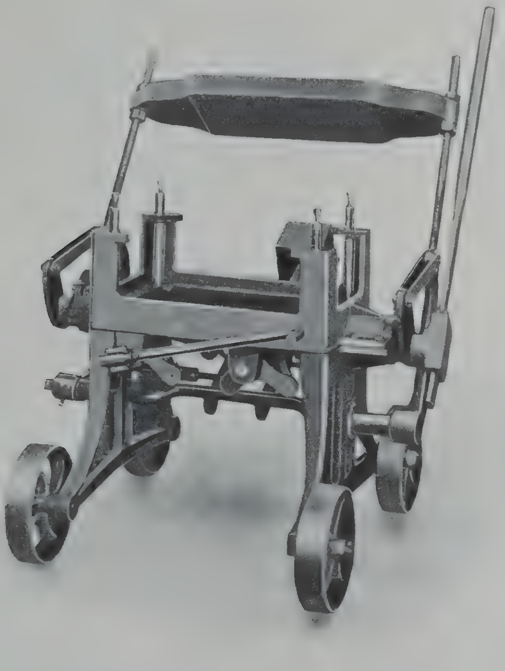


Fig. 1. Farwell Stool Plate Molding Machine.

In regard to the output, seven pairs of 38-inch steel-tired Allen wheels have been turned in 10 hours and 35 minutes. A record of tests before us shows that one pair was turned in 1 hour 10 minutes and the longest time required for a pair was 1 hour and 55 minutes.

THE FARWELL STOOL PLATE MOLDING MACHINE.

The half-tone, Fig. 1, shows a new form of the Farwell molding machine that is designed especially for stripping-plate work where stooling is necessary. Fig. 2 shows a plan and section of the machine fitted with patterns for an external and internal gear, which are held in the circular flask *F*. The hub of the pattern *B* and the rim *C* rest firmly at all times upon the pattern frame *H*, which is securely fastened to the frame of the machine. The stripping plate *D* rests firmly upon the adjusting studs *L* and the stool plate also rests upon adjusting studs, while the sand is being compressed. It will be seen that all parts which are subject to strain when the sand is compressed, have a rigid foundation and are not supported by cranks or connecting rods. Stripping plate *D* is fastened, by screws, to the rods *K*, which act as guides for both

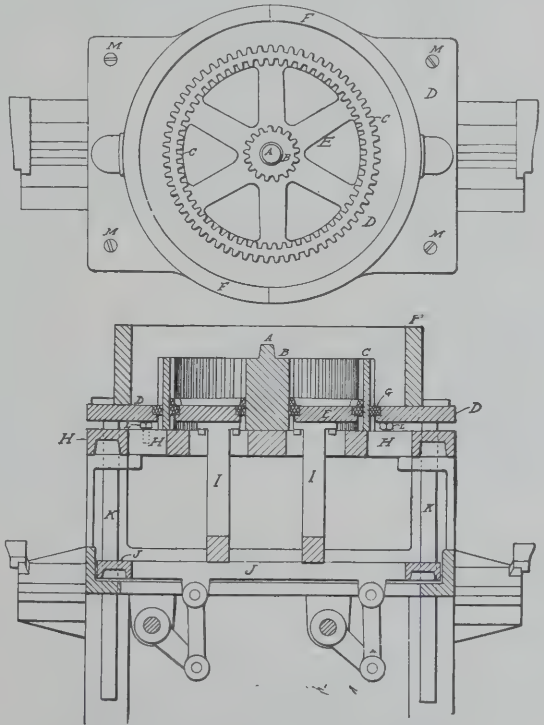
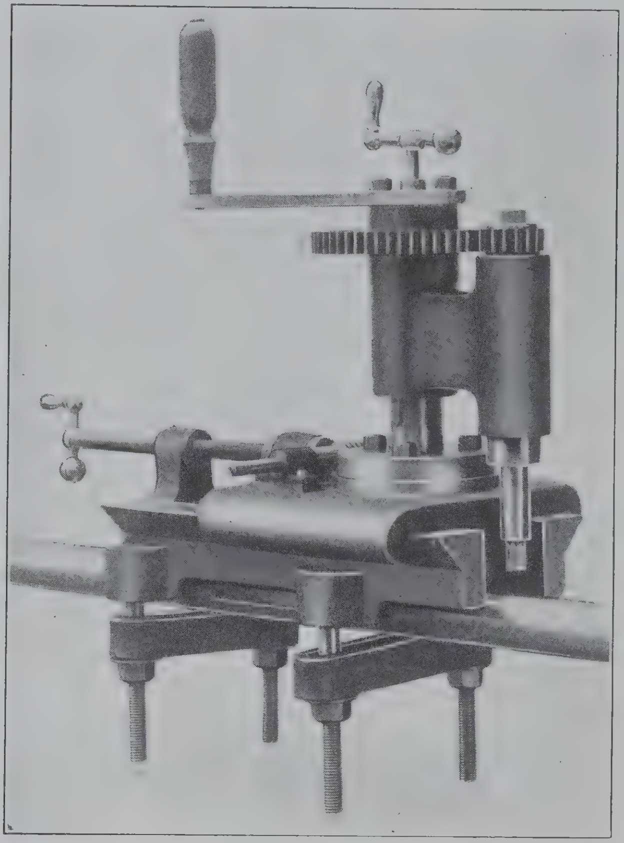


Fig. 2. Detail of Stool Plate Molding Machine.

plates and also connect the stool plate with the stripping plate. The stool *E* is fastened by legs *I*, *I*, to the stool plate. After sand is pressed the lift lever is operated, thereby raising the stool plate *J*. This also raises the stripping plate *D* and the stool *E*, and strips the patterns *B* and *C*, which remain stationary on the pattern frame *H*. The boss *A*, on the pattern, forms a core print in the sand while the spokes are fastened to the stool and follow it up when stripping the rim and hub. Babbitt metal is used where the stripping-plate meets the pattern to make a close fit. This machine is made by the Adams Co., Dubuque, Iowa.

NEW PORTABLE KEYSEATING MACHINE.

The photograph shows a new portable keyseater brought out especially for routing out the ends of milled keyseats and for truing up the sides of keyseats worn through loose gears, pulleys and couplings. The machine has a capacity for shafts up to 6 inches in diameter and will mill close up to a shoulder or flange. The bed of the machine which is clamped on the shaft, is made in V form, so that when the machine is fastened by the binders, it will be parallel with the shaft and the keyseats cut will be radial. The cutter spindle is carried by a turntable on the slide, the set-over for truing up worn keyseats being obtained by means of a worm and wheel adjustment. The part carrying the spindle is provided with a down feed screw so that the spindle can be lowered to the proper position and locked. The machine is fed by hand, the slide having a parallel travel, on the base, of 8 inches without re-setting.

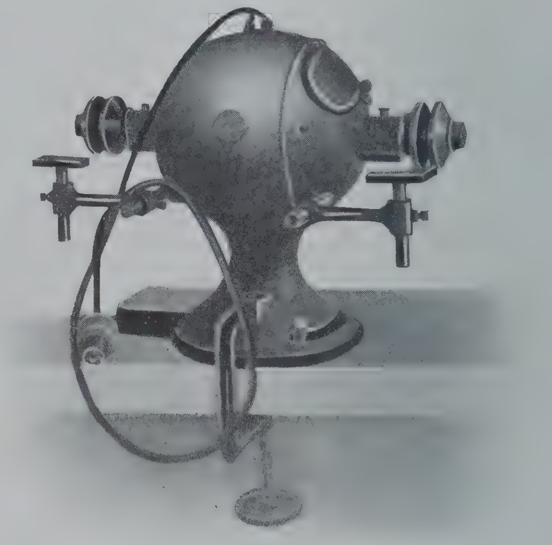


Burr Portable Keyseating Machine.

In routing the ends of milled keyseats the turn table is set to the zero line on the slide, the cutter fed down until it touches the bottom of the keyseat and the slide is fed up, with the cutter rotating, until the keyseat is routed out. In truing up worn keyseats it is advisable to use the set-over to the cutter-spindle, truing up first one side of the keyseats and then the other. This machine is also adapted to truing up worn keyseats on the axles of electric cars, these keyways often becoming distorted through gears working loose. The tool is the product of John T. Burr & Son, 34 South 6th Street, Brooklyn, N. Y.

THE "ANCHOR" ELECTRICALLY-DRIVEN BENCH GRINDER

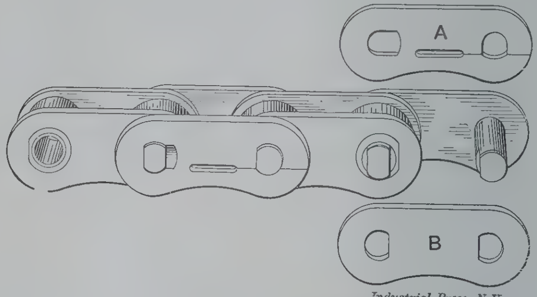
The Anchor Machine Works, Grand Rapids, Mich., has just brought out the electric bench grinder, illustrated herewith. This little grinder may be clamped upon a bench in any convenient place and is operated by the current from an incandescent lamp socket. When through grinding it can easily be put back out of the way, as it weighs only 55 pounds, and requires no other fastening than a hand clamp. The motor is inclosed in the body of the machine where it is free from dust and dirt, yet easily accessible for inspection and repair through swinging covers. It is started and stopped by means of a switch placed in the base. The spindle carries two wheels from 3 to 8 inches in diameter and up to 1 inch face. There are two rests, one for edge and the other for face grinding. The spindle runs at a speed of 3,000 revolutions per minute and the motor may be wound for a 110 or 220 volt current, as desired.



"Anchor" Electrically-driven Bench Grinder.

THE "WHITNEY" DETACHABLE CHAIN.

The cut presented herewith illustrates the new "Whitney" detachable roller chain which is the product of the Whitney Mfg. Co., Hartford, Conn. This chain has been adopted by one of the most prominent manufacturers of gasoline automobiles in the country and is claimed by the makers to be especially adapted to this class of work. As will be seen by the cut, it consists of a series of roller studs held together with steel side plates. *A* is one of the spring locking plates and *B* one of the regular plates. The regular plates cannot turn on the rivets on account of the irregular shape of the holes, while the locking plates prevent the regular plates from coming off. The chain is detachable at any point and can be taken apart quickly without difficulty when it is necessary to shorten it.



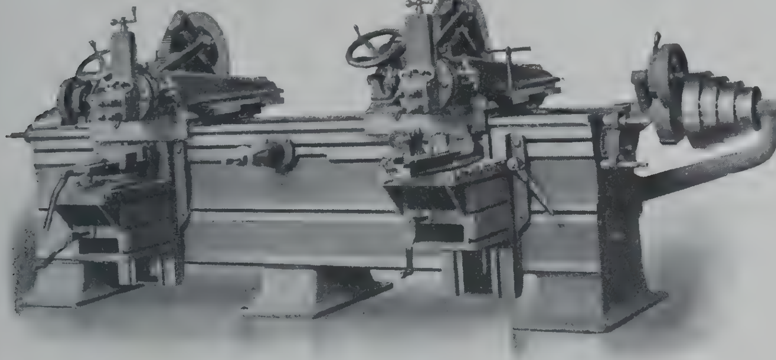
Industrial Press, N. Y.

Detachable Roller Chain.

TWENTY-INCH TRAVERSE HEAD SHAPER.

The Cincinnati Shaper Co., Cincinnati, Ohio, have just brought out the new 20-inch traverse head shaper that is illustrated in the cut on the next page. This machine, as shown, has two heads and is back geared, although it can be supplied with a single head or the back gearing omitted, if desired. The saddles, which are gibbed to the bed by taper gibs, are operated by full length and separate lead screws so that they are not limited to working, each at its own end of the bed, but may be brought together at either end of it. They may also be moved, for coarser feed or for positioning, by means of rack and pinion, by hand or by power, and the two feeds are arranged to lock against each other so that both cannot be accidentally engaged at the same time.

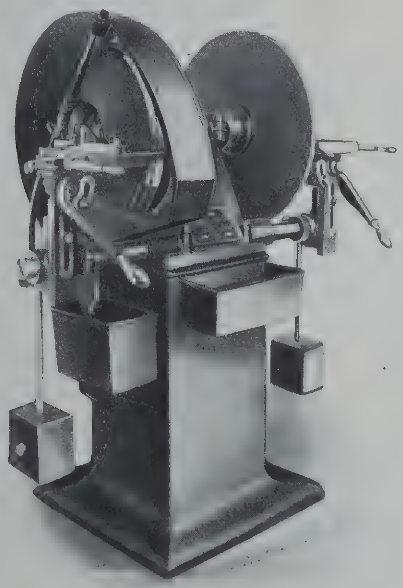
The rams are operated by the Whitworth quick return motion and are provided with rack and removable pinion wrench for positioning, both in relation to the work and for length of stroke. The stroke is adjustable from 0 to 20 inches, and a scale is provided by which it is set. The feeds, both for the saddle and for the heads, are located on the saddles where most convenient to the operator. They are automatic and the amount and direction of feed can be changed while the machine is in motion. They are so arranged that feed takes place on the return stroke while operating the saddles in either direction. The down feed of the head may be obtained by hand or automatically by power and may be set from 0 to maximum, as desired. The circular feed of the head is by hand. The feed of the circular arbor is by power and is operated from the front of the machine. The tables are of box form with T slots on three sides. They are removable vertically on the aprons and horizontally with them along the bed, crank wrenches being provided, as shown, for this purpose.



Twenty-inch Traverse Head Shaper.

COMBINATION DISK AND EMERY GRINDER.

The combination grinder, shown in the illustration herewith, consists essentially of a 23-inch disk grinder mounted upon one end of the spindle while upon the other end is an 18-inch ring of solid emery, mounted in a forged steel chuck, surrounded by a water hood and fitted with suitable pump and piping. This combination machine has been designed to cover two requirements that were not filled by the disk grinder. In the first place the disk grinder does not work well on large surfaces of cast iron or where too much stock has to be removed as the cast iron glazes; and again, there is a class of work that will not stand the heat engendered by the disk. The water grinder on this machine covers these two points while the emery wheel has the advantage of the very rapid speed of a disk grinder, speed that it would be impossible to use with a wheel mounted in the usual way.



Combination Disk and Emery Grinder.

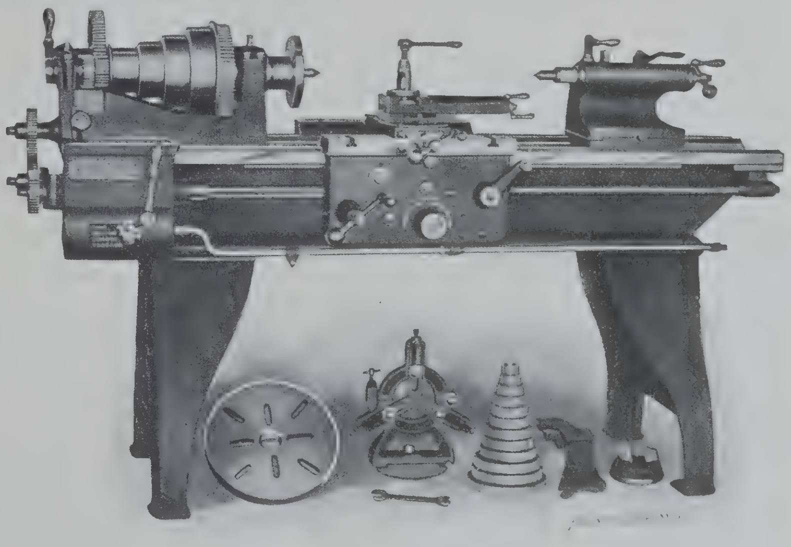
Both ends are furnished with an adjustable table which can be set at any angle and which has a rocking motion parallel with the face of the wheel. They also have a feed toward the wheel, operated by means of a lever and controlled by a micrometer screw. With these tables pieces can be sized to thickness and angles correctly ground. Furnished with the machine is a press for cementing the paper to the steel disks, of which there are two, and an 18-inch ring of emery carefully balanced in the chuck. This machine is made by the Bayldon Machine & Tool Co., Jersey City, N. J.

FOURTEEN-INCH "STAR" SCREW-CUTTING LATHE.

In the accompanying cut is shown the new 14-inch engine lathe that the Seneca Falls Mfg. Co., Seneca Falls, N. Y., have lately brought out especially for using high-speed steels with coarse feeds and deep cuts. It has an actual swing of 15¼ inches over the bed and 8⅞ inches over either plain or compound rest. The bed is 6 feet long and admits of taking work 34 inches long between the centers. The spindle is hollow and carries a four-step cone for 2¼-inch belt; the ratio of back gearing is 9 to 1. The tailstock is of the curved pattern which allows the compound rest to swing around parallel with the ways and over the base of the tailstock, with room to operate feed screw handle. The tail spindle has new locking device which insures perfect alignment.

The carriage is provided with T-slots for bolting on angle plates or work and is fitted with a cam locking device, in the apron, which locks it to the bed when the cross feed is in use. This device is operated by the same lever that operates the split nut on leadscrew, so that the split nut cannot be engaged with leadscrew when the carriage is locked to the bed. The cross feed screw is graduated to read in thousandths of an inch. Either plain, compound or rise-and-fall rests are furnished, as desired. The plain and compound rests are easily interchanged, one base and tool post answering for both. The compound rest has extra long travel of 5¼ inches and is capable of fine adjustment as the base is graduated.

Power is transmitted from head spindle to leadscrew entirely by gears and is arranged with three changes of feeds, fine, medium and coarse, whose ratio is 4—2—1; these changes may be instantly made while lathe is in motion, by shifting the hand lever on gear cage. An automatic stop is provided to stop carriage at any point. The friction feed, both cross and longitudinal, is thrown into operation by a single hand knob, on the apron, which operates a double friction clutch connected with the worm gear. This construction effectually prevents cross and longitudinal feeds from being put into operation at the same time. The worm, by which the worm wheel is driven, is keyed to the leadscrew which is splined so that it simply acts as a feed rod, therefore the only wear on the threads is in screw cutting.

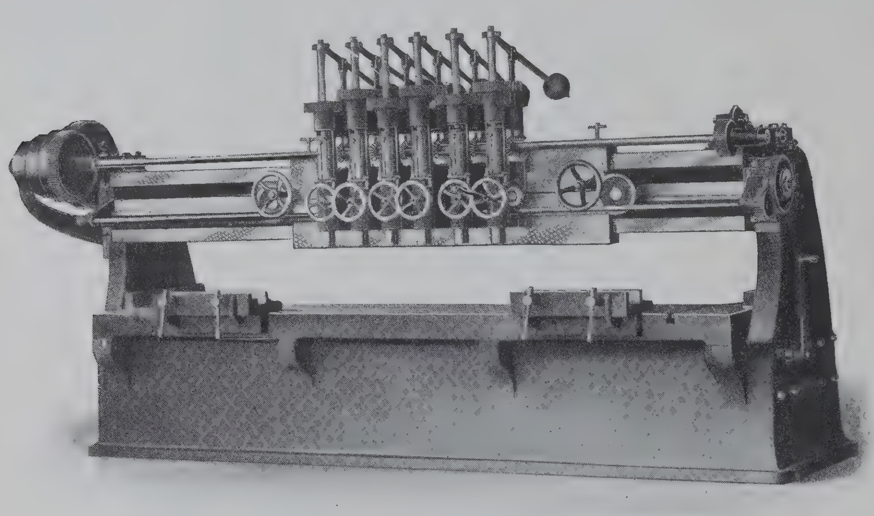


Fourteen-inch "Star" Screw-cutting Lathe.

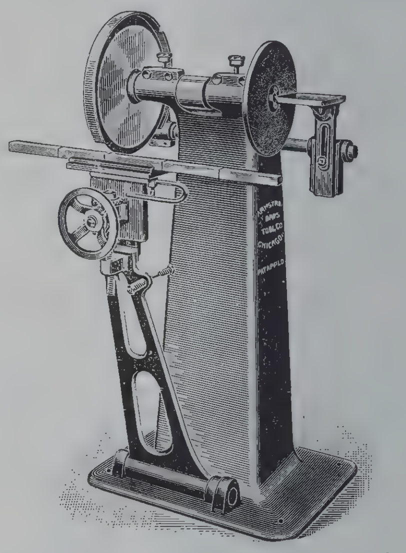
The screw cutting range covers all standard threads, from 3 to 64, including 11½ and 27, without compounding the change gears. The leadscrew has U. S. Standard threads, and, when desired, transposing gears and the International Standard Index for cutting metric threads from 0.5 millimeter to 8 millimeters are furnished. When cutting threads the hand lever on the gear cage should point to "Threads." The automatic stop will not operate when the hand lever points to "Threads." When desired, a taper attachment will be furnished which is secured to the back of the carriage, travels with same, and is always in position ready for use. It is connected to the bed by means of a screw clamp.

MULTIPLE SPINDLE MUD RING AND FLUE SHEET DRILL.

This drill, which is shown in the half-tone herewith, is designed especially for mud ring and flue sheet drilling on locomotive work but it is also suitable for any other type of multiple drilling. The distinctive feature lies in mounting six independently fed heads, which are adjustable in their center distances on an auxiliary cross rail; this cross rail in turn being adjustable the entire length of the main cross rail. By this means a mud ring can be dropped into the two chucks shown on table, securely clamped, then without moving the work in these chucks, either one or two rows of rivet holes can be drilled the entire length at any spacing desired. All that it is necessary to do, is to set the heads on the auxiliary cross rail at any given multiple of the pitch of the rivet holes. For instance, if the rivet holes come at 2-inch centers, set the heads at 6-inch centers, and drill six holes simultaneously, then move the auxiliary cross rail carrying the six heads 2 inches and drill six more, repeating the operation the entire length of either mud ring or flue sheet. In case there are two rows of holes in the mud ring, after the first row is completed, the table would be adjusted out or in as the case might be, whatever distance is required between the two rows of holes when the operation would be repeated.



Multiple Spindle Drill for Drilling Mud Rings and Flue Sheets.



Machine for Cutting Off Self-hardening Tool Steel.

For flue sheet work, the same mode of operation would be pursued, the chucks having been first removed from the table. Length in the clear of this machine is 12 feet 4 inches between uprights; working surface of table is 12 feet 4 inches by 24 inches, having three T-slots the entire length. The table has an out or in adjustment of 24 inches, the shaft for operating this table extending out at both ends so that it can be operated from either side of the machine.

It will be clearly seen to what a variety of multiple spindle drilling such a machine can be adapted, the various adjustments provided for the heads permitting them to be accurately set at definite positions so that the machine can be used as a jig drill for accurate duplication of work. The drill is provided with four spindle speeds and three feeds, and weighs, as shown, about 17,500 pounds. The manufacturers are Foote, Burt & Co., Cleveland, O.

MACHINE FOR CUTTING OFF SELF-HARDENING STEEL.

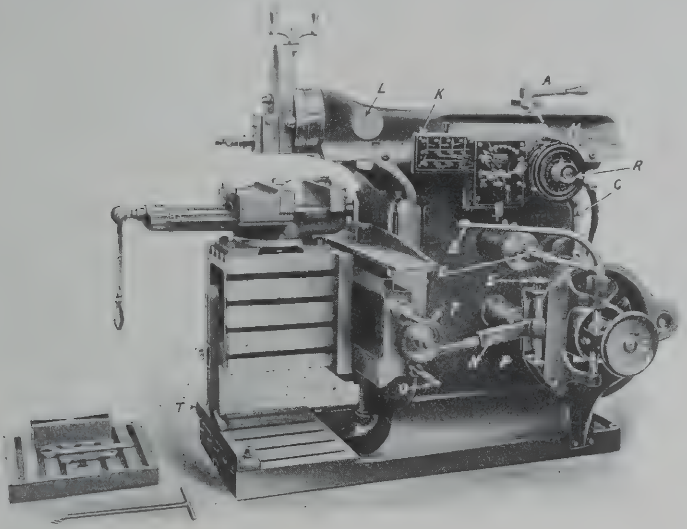
The Armstrong Bros. Tool Co., Chicago, Ill., who are the builders of the machine here illustrated, are also manufacturers of tool holders for using self-hardening steel, and in this branch of their business they have had occasion to cut large quantities of this steel to lengths. Experience has taught that this class of steel gives best satisfaction if cut cold, although the ordinary shop practice has been to cut it hot or to break it on an anvil. The objection to the latter method is that the break is liable to be irregular, resulting not only in loss of steel but in increased grinding with waste of time and of emery wheels. After experimenting with various methods the builders adopted the machine here shown and it has given perfect satisfaction for a period of two years. The cutting is done by a disk of special grade of tool steel which is revolved at a high rate of speed. Any attempt to cut soft steel or ordinary cast steel with a disk results in a rough dragging cut, with flaring lips which bind the disk to such an extent as to reduce its speed to a point where it is ineffective, if it does not actually bend or break the disk. Owing to the peculiar nature of self-hardening steel, however, it is not affected in this manner by the cutting disk, which makes in it, even when forced hard, a clean, clear-cut incision. The periphery of the disk is coated with self-hardening steel particles, and these particles do the actual cutting.

Having had many inquiries as to their method of cutting off self-hardening steel the manufacturers of this machine have decided to place it on the market in the combination form here illustrated. The steel cutting disk is mounted on one end of the spindle while the other carries a 12-inch grinding disk, the speed at which the spindle runs being such as to give the best results for both operations. Over the cutting disk is a guard which can be easily swung back out of the way when the disk is being changed. The swinging table is provided with a length gage and is conveniently adjusted both for depth of cut and to take steel of different sizes. The grinding disk is provided with an adjustable table so located that the operator will not interfere with long bars that are being cut off by the disk.

VARIABLE SPEED MOTOR-DRIVEN SHAPER.

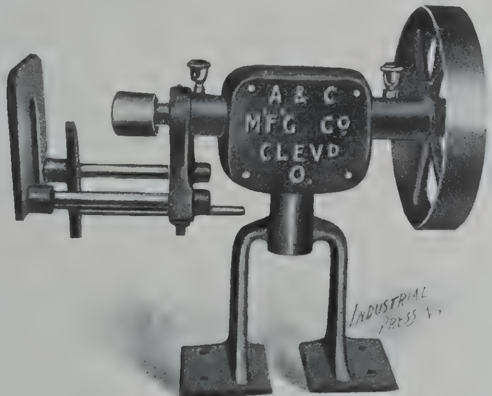
The comparatively recent advancement in rapid machine work that has been made possible by the introduction of "high speed steels" has naturally called for changes and modifications in the design of machine tools to meet the requirements of the increased duty which they are called upon to perform. To meet this demand the Gould & Eberhardt Co., Newark, N. J., have been making a series of improvements upon their shapers which have resulted in the new motor-driven machine shown in the accompanying engraving. The builders are advocates of the individual motor application to machine tool driving, in favor of which they cite many of the advantages embodied in their new shaper which would not be possible if the machine were one of a group, or where any change of speed of the motor would affect the speed of all of the machines in the group.

In the new shaper all of the operating handles are brought within easy reach of the workman, while some important details formerly requiring hand adjustment are now made automatic in operation. The position-fixing nut of the ram works on a finely toothed washer and seat, thereby avoiding slip, and is provided with an index finger reading the ram stroke in inches on the full sized scale *H*. A power down feed, not shown in the cut, can be attached to the pad *L*. This is regularly furnished on the 28-inch and 32-inch shapers and is applied to the smaller sizes when desired. The head turns through a full circle and is graduated in degrees.



Electrically-driven Shaper.

The ram bearings are extended forward so as to give a long bearing in the frame when the ram is at extreme forward stroke. The vise has a large range and is provided with extra jaws for tapers and rounds while a pair of centers is fitted to the top of the regular jaws. The large base of the vise revolves through a full circle and is graduated in degrees. The outer end of the vise body is a steel casting thus providing a hard part of the body that can be hammered without harm. The pillar is extended in front, thereby adding substantially to the base area of the machine, and to this extension the knee-supporting truck *T* is bolted. The knee-elevating screw is operated by the shaft *O*, at the right end of the cross rail, by means of the same handle that operates the feed screw. The knee feed is by an eccentric groove in the side of the variable ram crank gear which oscillates the outside double-end rocker fork *P*, carrying a double threaded screw, and having the hand feed adjusting knob *E* at the top end. The pawl rod *N* is jointed to the feed adjusting screw nut and a scale on the side of *P* shows the number of ratchet teeth covered by the pawl movement. The pawl rod *N* automatically adjusts itself to the different lengths demanded by different cross rail heights, by means of two stop studs which limit the pawl arm travel each way and by a screw-adjusted, leather-faced friction slip device formed in the body of the rod *N*. The friction is enough to drive the cross feed but will yield, without damage to anything, if the knee is carelessly fed to the cross rail limit. The pawl ratchet carries a spur gear which drives the feed screw pinion so that wide feeds may be had, and different gears and pinions are used to give fine or coarse feed as may be required. The ram drive is by a slotted vertical lever with a sliding block and screw-adjusted crank wrist secured by nut *D*, which is both hand and wrench tightened, so that the crank wrist shifting handle may be applied, and both hand and wrench nut tightening may be done without stopping the ram. The workman is thus enabled to vary both ram stroke and ram position without stopping the machine.



"Cleveland" Automatic Tapping Machine.

The electric-driven shapers are made for both constant and variable speed motors. The constant speed motor requires a four-step cone on the armature shaft corresponding to the cone on the shaper for obtaining the variations in speed which, together with the back gears, give eight speeds. The illustration shows the shaper with a variable speed motor and a back gear speed change operated by the lever *C*. In making the back gear change the pinion shaft is unclutched by a single motion of lever *B*, which has a brake attachment enabling the operator to stop the machine instantly, at any part of the stroke. The motor shown is wound for any single voltage, direct current and is started by the knife-switch, *K;* its speed is controlled by the rheostat knob *R*, and by the back gear change obtained through lever *C*. All of the ram stroke variations, from 100 strokes per minute single geared, to five strokes back geared, can be made inside of 10 seconds actual time. The hand-wheel *G* on the other end of the pinion shaft, gives a very convenient hand movement of the ram, either way, as may be desired by the workman in setting the tool.

THE "CLEVELAND" TAPPING MACHINE.

The A. & C. Mfg. Co., Cleveland, O., have recently placed on the market the automatic tapping machine shown in the accompanying cut. It is designed for using taps of ½-inch diameter and under, and can be fitted with any style of chuck, or tap holders of any required size can be furnished in place of the chuck. There is a sliding guide for the work so that accurate duplicate tapping can be performed. The reversing device is automatic, the machine reversing itself when the depth required has been reached by the tap. If a die be substituted for the chuck the machine can be used equally well for cutting threads.

In the February number was published an item, credited to an English publication, regarding a transparent chart designed to facilitate the making of perspective sketches and drawings, without the usually tiresome process of finding the vanishing points and locating the different parts of the drawing in proper relation. We have since learned that this useful invention is an American production, invented and sold by Mr. G. Curtis Gillespie, Architect, 7 and 9 Warren street, New York, who will be glad to answer any inquiries.

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FRESH FROM THE PRESS.

The Derry-Collard Co., 256 Broadway, New York. Booklet entitled "Turning and Boring Tapers." This is the first of a series of practical papers intended to be of use to the man in the shop. These papers are to be uniform in size and style, and it is intended to treat of only one subject in each of them, so that any particular information desired may be had without purchasing a large volume. The price of each number is twenty-five cents. No. 1 contains information on the subject above mentioned, simply and clearly treated, with numerous sketches.

Modern Machine Shop Tools, Their Construction, Operation and Manipulation, by Wm. H. Van Dervoort. Published by Norman W. Henley & Son, 132 Nassau St., New York. 552 8-vo. pages. Illustrated. Price $4.

This is a volume in which the readers of Machinery will take a personal interest, from the fact that Prof. Van Dervoort has been a contributor to our columns of extended series of articles, upon shop practice. These articles form the basis of this book, but have been revised or rewritten, and supplemented by extensive additions.

For a long time there has been a demand for a book covering the fundamental principles of shop work. In these days it is almost impossible for a machinist to become proficient in the use of all the different tools and machines found in machine shops, and the tendency is for a machinist to work indefinitely along certain lines instead of becoming an all-around mechanic, as formerly. We believe, therefore, there are a great many who will be glad of a reliable treatise that explains in a clear manner the simple elementary operations in using the tools—both hand and machine tools—most commonly found in shops. Such a book to be of real use should answer the questions that apprentices would ask and that a machinist would often like to ask were he not ashamed to do so.

Prof. Van Dervoort has had exactly the experience needful for completing such a task, and he has succeeded admirably. He, himself, is a practical machinist as well as a technical graduate. He has taught machine shop practice at the Michigan Agricultural College and the University of Illinois, and is now a machine shop proprietor, so that he has been able to face the subject from many sides. Naturally the numerous questions that would come from his students in teaching have been taken up and answered in the text.

This is a book of reference that would be found convenient in every machine shop. Suppose it were desired to know how to cut bevel gears, to calculate milling machine spirals or to make countershaft calculations; or to get information about tap drill sizes, the classification of files; change gear calculations; deep hole drilling; turning tapers; testing lathes, etc.; or any one of the numerous questions that a little information might be desired upon occasionally—these pages would in all probability contain the satisfactory answer. The book will also prove a boon to students in manual training, as by studying its pages and applying its principles to the school shop, they will be able to acquire a good knowledge of shop practice. The book has numerous tables, and in addition to the chapters strictly on tools are several on fastenings, gearing, belting, shafting, and the treatment of steel. The only criticism we have to make is with regard to the illustrations. They are well chosen and illustrate the text in a satisfactory manner, but many of them are made in a way to detract from the appearance of the work. There are nearly 700 of these illustrations and we trust that in future editions the publishers may see fit to improve the appearance of the book in this respect.

Steam Power Plants, Their Design and Construction, by Henry C. Meyer, Jr. Published by the McGraw Publishing Co., 114 Liberty St., New York. 160 pages. Illustrated. Price $2.

The matter in this book was written to give information to owners or managers of manufacturing plants and buildings, requiring power installations. While it is advised in the text to employ an expert engineer to superintend line operations it frequently happens that a man of mechanical training but without specific knowledge in the matter of power station work has to make the plans and assume the responsibility. It is believed that this book will be of special value to this class and also to manufacturers who want to obtain some general knowledge of power plants from a technical standpoint. Many of the chapters in this book first appeared in the *Engineering Record*. They are well written. There are numerous illustrations taken from the pages of the *Engineering Record* which are not designed especially to illustrate the text, but are intended rather to be helpful to the reader, by the suggestions they may offer upon the subject of power installations.

NEW TRADE LITERATURE.

The Loop-Lock Machine Co., Waltham, Mass., successors to the American Watch Tool Co. Circular giving illustrations of the Webster-Whitcomb lathe and attachments, with price list.

The Rochester Machine Tool Works, Ltd., Rochester, N. Y. Catalogue of the "Acme" engines and boilers, for natural gas, kerosene, coal, wood or coke. These are built in seven sizes. The "Acme" stationary engines are also described and illustrated.

H. W. Johns-Manville Co., 100 William St., New York. Folder, "How to Pack Gas Engine Cylinder Heads," giving full instructions for cutting gaskets, preparing for the flange and applying the gasket so that the most efficient service may be obtained. This may be had by addressing the company in New York, or at any of their branch offices.

The Rand Drill Co., 128 Broadway, New York. Circular No. 2 illustrating the "Imperial" pneumatic tools manufactured by this company. It describes various sizes of "Imperial" air compressors, steam, belt or motor-driven; pneumatic tools, motor hoists, rock drills and air appliances of all kinds. Various classes of work performed by the aid of these tools are shown in the circular.

H. B. Underwood & Co., Philadelphia, Pa. Catalogue 1903 of portable tools for railway repair shops. Among these are portable boring bars for boring out locomotive cylinders, for Corliss valve seats, and for general boring; boring bars for lathe work; portable valve seat rotary planing machines; locomotive cylinder or dome facing machines, crankpin turning machines, etc. Some useful tables are also given.

Pawling & Harnischfeger, Milwaukee, Wis. Unique little folder containing a list of users of this company's cranes and hoists. The cover of this folder is only 3x4½ inches, but the list is folded accordion fashion and is (if we may be permitted to state it so) some 6 yards in length, a large number of prominent firms being represented. A list 18 feet long of customers is impressive, to say the least.

Charles H. Besly & Co., 15-21 Clinton St., Chicago, Ill. Illustrated catalogue, 1903, of the Gardner grinders, the Besly band grinders, and polishing machines, spiral circles for use on Gardner grinders, Helmet oil, Badger oil cups, etc. The Gardner grinders are shown in a variety of styles and sizes, and samples of the work done on these grinders are also shown. This catalogue should prove useful to those interested in this company's products.

The J. T. Slocomb Co., Providence, R. I. Catalogue and price list of machinists' tools. These include the Slocomb micrometer calipers in sizes from ½ inch to 12 inches. They also illustrate their 3-inch, 6-inch and 12-inch micrometer sets in cases, which include the various sizes of micrometers for measuring different kinds of work; and their screw thread micrometer, with pointed tip for use when cutting screw threads.

The Hendey Machine Co., Torrington, Conn. Illustrated catalogue, March, 1903, of the Hendey-Norton screw-cutting engine lathe. Those interested in this machine will do well to secure this catalogue, which contains full particulars as to its construction, and the uses to which it may be put. Sizes from 12-inch to 32-inch are shown, also four sizes of metric lathes. Pillar and traverse shapers in various sizes are also shown, and cuts appear showing the Hendey lathe, and also their shaper, arranged for motor-drive.

The S. Obermayer Co., Cincinnati, Chicago and Pittsburg. Circular describing the "Peerless" follow board compounds for making follow boards for foundry use. The solid and liquid compounds are mixed until of a consistency thin enough to pour, and are cast around the pattern. After drying for 36 hours the pattern is removed and the follow board thus produced is ready for use. It becomes harder with age and the older the mixture, the better for practical use. Follow boards made up with these compounds are as strong as wood and will neither shrink nor swell; they produce perfect partings with sharp and durable edges.

The New York Belting & Packing Co., Ltd., New York. 1903 catalogue of rubber goods for mechanical purposes. Rubber endless belts, rubber hose for use in air drill and pneumatic tool work, for car heating, gas lighting, etc.; suction hose, fire hose, mill hose are here illustrated and described. Also a great variety of packings, such as high-pressure spiral piston and valve rod packing; hydraulic packing, for cold water and high pressure; and ring and piston packing. Rubber tubing, and a large number of rubber specialties are also manufactured by the firm.

The Niles-Bement-Pond Co., 136-138 Liberty St., New York. Catalogue 9x12, of horizontal boring and drilling machines. This is a very handsome work, with excellent half-tone views of the above-named machines and text printed in neat, clear type. Here are illustrated horizontal boring and drilling machines with single and with double heads; single and double head drilling, tapping and stud-inserting machines; horizontal boring, drilling and milling machines, of which 19 sizes and styles are shown, the larger sizes for the heaviest

New Knowledge on Belt Management, issued by the Cling-Surface Mfg. Co., Buffalo, N. Y.

This is a neat little book, bound in cloth, and is a very attractive bit of advertising literature issued by the makers of the Cling-Surface preparation for belts, to extend the knowledge of Cling-Surface and of the results obtained through its use. The principal part of the book is taken up by a concisely written article, upon Cling-Surface and Belt Management, by John E. Powers. It tells all about belts, their care and treatment, what they can be depended upon to do and what Cling-Surface has done for them. It is a practical little work and is very readable.

work. Then follow illustrations of the work done on these machines, such as boring spindle bearings, boring and facing headstock bearings, and parallel holes at one setting, and milling surfaces in places difficult to get at, etc. The company also build a line of smaller horizontal drilling and boring machines with spindles from 2½ to 6 inches in diameter, for smaller work.

MANUFACTURERS' NOTES.

In the description of the 34-inch Colburn vertical boring mill, published in the April issue of Machinery, we omitted the name of the selling agents of this machine. The Brown & Zortman Machinery Co., Pittsburg, Pa., are the exclusive selling agents.

The Western Tool Works, Chicago, Ill., inform us that they expect about May 1 to double their capacity and space.

The Pedrick & Ayer Co., Plainfield, N. J., notify us that Mr. Geo. E. Martin, formerly connected with them as superintendent of their shops, recently tendered his resignation which was accepted.

The Patterson Tool & Supply Co., Dayton, O., inform us that Mr. A. J. Strong, formerly head of the tool designing department, National Cash Register Co., Dayton, is now traveling salesman for their company.

The Robertson Mfg. Co., of Buffalo, N. Y., manufacturers of hardware specialties, grinding machines, mechanics' tools, etc., inform us that they have removed their works from 203 West Utica St. to 1453 Niagara St., that city.

George E. Affleck, 109 Liberty St., New York., dealer in all kinds of new and second-hand machine tools, has removed to 107 Liberty St., where he will occupy the entire store, and will carry about four times the previous stock.

Pawling & Harnischfeger, Milwaukee, Wis., had a fire at their works on the night of April 15, but fortunately it was confined to one building only, and they report that they were but very little handicapped, the remaining buildings being ample to take care of their work and having immediately been adjusted to do extra duty.

The Yale & Towne Mfg. Co., 9 Murray St., New York, are offering prizes for information from mechanics concerning Triplex chain blocks. This contest is open to all, and practical statements are the only thing required, not fine writing. For further information regarding this, we refer those interested to the advertising columns of this number.

The Buffalo Forge Co., Buffalo, N. Y., announce the establishment of a new branch office at 1409 Majestic Bldg., Detroit, Mich. The offices are being equipped with every modern facility. As heretofore, the Michigan district business of the company will be in charge of Mr. H. M. Brightman.

The Arguto Oilless Bearing Co., Wayne Junction, Philadelphia, Pa., have broken ground for an addition to their present plant that will double their capacity. The large and steady increase in the demand for their bearings has made the call for larger quarters imperative.

The Mossberg & Granville Mfg. Co., Providence, R. I., manufacturers of presses, etc., have recently purchased the large factory formerly occupied by the Phœnix Iron Foundry, on Elm Street, Providence, and will move into it on June 1. This company's business has called for larger quarters for over a year, but it is only recently that a suitable location was found.

The Worcester Emery Wheel Co., formerly located at 100 Exchange St., Worcester, Mass., have outgrown their old quarters and moved into their own plant on Chandler St. They have purchased the large four-story building recently occupied by the Optical Co. Mr. A. D. Putnam, formerly assistant treasurer of the Barnard, Sumner & Putnam Co., Worcester, Mass., has been made general manager.

The National Tool & Stamping Co., Fort Wayne Junction, Philadelphia, Pa., report that they have been awarded a $40,000 contract for "vending" machines by the Doremus Automatic Vending Co., New York. Mr. Stewart H. Heist is at the head of this company, which has only been equipped for business a few months. The concern will manufacture dies, tools, boiler punches and sheet metal novelties. They have a new process which they claim will harden and temper all kinds of springs, insuring a perfect product at very reasonable prices.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line.

The money should be sent with the order.

ADVERTISING and catalog expert of wide experience desires position with some Chicago house. Commission, salary or contract. Address, GREEN, care Machinery, 66 West Broadway, New York.

ADVICE, information or expert opinion on all matters relating to die-making, sheet-metal working, toolmaking and interchangeable manufacturing. Fees moderate. JOSEPH V. WOODWORTH, I. M. E., Station A, Brooklyn, N. Y.

A NEW drill drift; always ready; self-contained; quick acting; no hammer needed; low price. MARIA STEIN MCH. WORKS, Maria Stein, O.

BOOK, "DIES AND DIEMAKING," 100 6x9 pages, $1, post paid; send for index. J. L. LUCAS, Bridgeport, Conn.

BUYER wants position in Chicago. Thorough in machinery, tools and supplies. Address, BUYER, care Machinery, 66 West Broadway, New York.

CORRESPONDENT of 10 years' experience desires to locate in Chicago. Thoroughly competent with general office details and mail order business. Address, VARIETY, care Machinery, 66 West Broadway, New York.

ENGINE DESIGNER of wide experience, capable of developing a line of high-speed steam engines, wanted to take responsible charge of the drafting and designing department of a large and well-known New England firm. A permanent and growing position is open to a man of first-class executive and technical ability. Address, NEW ENGLAND, care Machinery, 66 West Broadway, New York.

EXPERIENCED mechanical draughtsman wanted. Permanent employment assured to rapid and accurate draughtsman. Address "MILL WORK, care Machinery, 66 West Broadway, New York.

FOR SALE CHEAP.—An office telephone system with five stations, in good order. Address, "TELEPHONE," care of Machinery, 66 West Broadway, New York.

EXPERT Wrecking Crane Engineer seeks situation railroad or city job. First-class references. Reply to "CRANE ENGINEER," care Machinery, 66 West Broadway, New York.

Continued on page 38B

MACHINERY.

June, 1903.

THE EVOLUTION OF THE CHANGE GEAR.—1.

A STUDY OF THE UNITED STATES PATENTS ON LATHE CHANGE GEAR DEVICES.

OSCAR E. PERRIGO.

The question of the change gears of lathes and the great amount of time and inventive genius that has been devoted to the matter in the last few years would seem to render the subject one of considerable interest to the men who design lathes, the manufacturers who build them, the men who buy or use them, and the men who are interested in the obtaining of patents upon their various and almost multitudinous devices.

The matter has been taken up with the view to ascertaining what there may be in this line which has been secured in the United States Patent Office; to give diagram illustrations of the prominent features of each device in itself, and to compare and contrast its various claims to usefulness, both in a commercial and in a practical way, with other inventions of its class.

It is undoubtedly true that there may be very commendable devices on the market to-day, put forth on a quasi claim of being patented, which have never seen the inside of the Patent Office, except possibly to be put on the immense list of rejected applications.

The careful and methodical reader is assured that although the copies of no less than one hundred and fifty-six patents have been considered, covering as they do many phases of variable speed mechanism, the twenty-seven patents hereinafter described and illustrated contain all of the subject matter from the patent of Bancroft and Sellers in 1854 to that of Johnson, August 12, 1902.

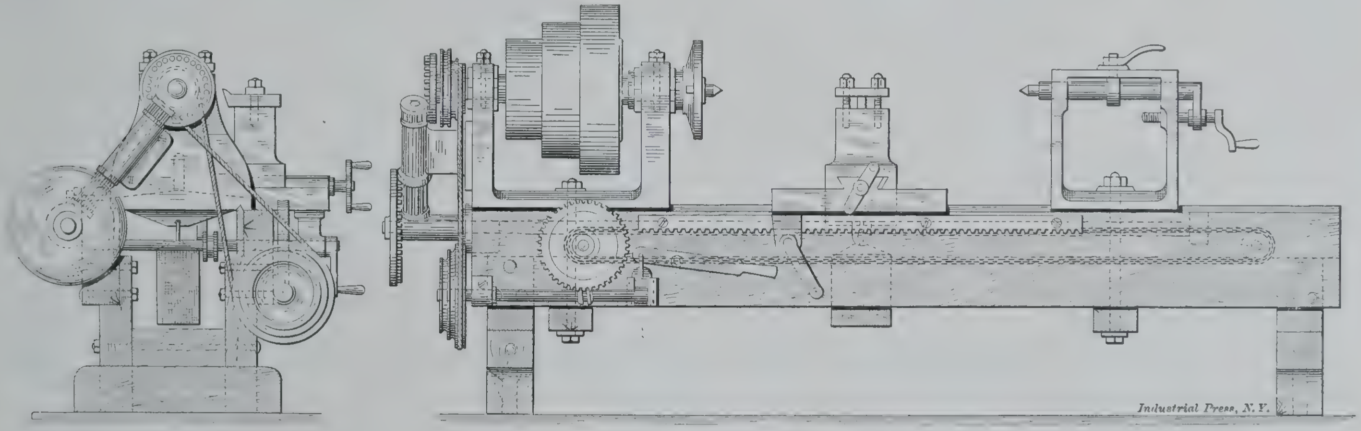

Industrial Press, N. Y.

Fig. A. Our Old Friend, the Chain Lathe.

And in reviewing these various patents the first consideration has been to get at the *germ* of the invention, to illustrate its good points "for all they are worth," and in comparison with others to give all due credit which the mechanical knowledge of the writer feels to be fair and just. If inventors feel that their devices are underrated they are heartily assured that there is no desire to in any way belittle their work, but rather to bestow "honor where honor is due."

It would seem appropriate just here to mention some of the points which impressed themselves on the mind of the writer during the long and careful consideration of this subject. Of course it is expected that there will be those who will not agree with the writer's opinions or deductions as to the construction or merit of the various inventions. To these good people there is one thing to be said. It is this. When you don't like what is said and you feel like criticising these articles (or any statements made in them) which are contributed in an honest effort to advance the general knowledge of the subject; don't get indignant and rush into print. Work off your surplus bile in some other way, and when you have arrived at the blissful condition of superiority of judgment necessary for the occasion, sit down and write an article on the same subject a great deal better and a great deal more correct than the author has done. It will serve several useful purposes. The general public will get the benefit of your special knowledge, the editor will pay you well for it, and you will have eased your mind; thus combining a public duty with pleasure and profit to an eminent degree.

One of the features in patent drawing which strikes a practical mechanic very forcibly is that very few of the drawings are so made that even an operative model could be made from them, much less a practical working machine, without supplying much in the way of mechanical detail and design. Various views and groups of parts are found utterly impossible to assemble as they are drawn. Sometimes in two adjacent views one is reversed and not a similarity of form or the presence of reference letters to show the fact. In one case a sliding piece was required to move fifteen inches and had formed upon it a rack which could not be cut with over three teeth to an inch, and this was operated by an eight-tooth pinion on the end of whose shaft was a lever which could move only through an arc of 90 degrees, hence the rack would move less than an inch instead of fifteen inches. And so on *ad infinitum*.

It frequently happens that inventors are not practical men from a commercial point of view. Their devices may possess merit, but it is frequently so covered up with unnecessary complications (by machinists called "traps"), that they are of little commercial value until these idiosyncrasies are eliminated by a practical man who has the ability and foresight to seize the germ of the invention and to so arrange the construction of the device as to make it of real commercial use and value. This frequently amounts to the mechanic making almost the entire invention, and in reality to his rendering it of practical value. At the same time he seldom gets any credit for what his mechanical ability has produced.

From time immemorial it has been one of the vexing questions in the blacksmith shop as to which was the first of the blacksmith's tools, the hammer or the tongs. If the question was asked, Which one of the machines was first used in the machine shop, nearly every machinist would unhesitatingly say, the lathe. And while the lathe is also probably the oldest of machine tools, it is the most important in many respects today. Many of the other machine tools might be spared and the work done in some other way. But the lathe is the one indispensable machine that the machinist *must* have. With it he can turn, bore, face, mill, plane, slot, and in fact do almost every kind of work done by any machine tool in the shop. It is verily the king of machine shop tools. And yet, while it is probably the first machine tool devised, it is only in comparatively recent years that it has arrived at anything like its present state of perfection.

In considering the subject of change gear devices for lathes it may be well to refer briefly to the early history of turning lathes and then to their later development, not only of the devices for thread cutting, but of the lathe itself. Going back to the early history of the lathe, we know that Theodorus of Samos, B. C., 560, is said by Pliny to be the inventor of turning, but while many believe that this species of "turning" perhaps referred to the "Potter's Wheel," used in forming clay into circular vessels, it is undoubtedly true that the "Potter's Wheel" was known centuries before, since it is several times spoken of in the old testament.

It seems to be a fairly well conceded fact that the first turning lathe ever devised was a very crude affair and consisted of a spindle pivoted to two trees or to blocks fastened to the trees and propelled by a cord whose upper end was attached to a flexible limb of one of the trees, from whence it passed down to the spindle, took a turn around it, and then continued down to a treadle to which the power was applied. It is probable that in its gradual development a balance wheel may have been attached to the spindle and that it was propelled by an assistant. Later the idea of a crank was probably added and some sort of pulleys, most likely grooved ones, were discovered and the convenience of increased speed made possible. Thus far it is likely that the use of the lathe was for turning articles of wood or ivory, but it was not a long step to turning articles of metal. Thus these simple mechanical contrivances were devised for the use of the early mechanics, who in their gradual improvements must have hit upon the idea of screw threads for bolts used in fastening their work together. While it is probable that Archimedes, B. C. 287, had an idea of the form of a screw it was a long while after his time before the idea was applied to the formation of screw threads as we know them to-day. It is probable that the first screw threads were made on wood and that they were "chased" with a hand tool. The writer remembers an old shop in the country where, in a certain form of woolen spinning devices a worm and worm gear was wanted and it was made by wrapping a piece of paper around the turned cylinder which was to be the screw, and cutting through this with a knife so that it would become the exact development of the surface of the cylinder. This paper was then laid off for the pitch as shown in Fig. B. It was then glued around the cylinder and the diagonal lines became the developed screw thread. Then with a fine saw, a chisel and a file the thread was cut in a proper V form. The wooden wheel was spaced off and the teeth cut in a similar manner, not with a curved pitch line, of course, but straight as in a spur gear. It was surprising what an amount of wear these crude worms and wheels would stand.

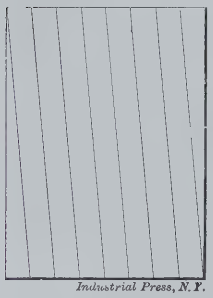


Fig. B. Development of Screw Thread.

Following along in the gradual development of mechanical devices threads were cut on metal, "chasers" still being used for this purpose. With the crude hand tools then in use, this was a very slow and laborious process until some genius more far seeing than his fellows developed the idea of cutting a thread from one already made, on the principle of the "gauge lathe." This idea is illustrated in the accompanying sketch, Fig. C, in which such a lathe is shown in plan, and in which *A* is the screw already cut; *B* is the piece to be threaded, adjusted in proper supports and the one driving the other; a slide carrying at one end a former point *C*, engaging the thread and at the other a cutting tool *D*, for chasing the thread. From this device doubtless proceeded the idea of making the screw a permanent part of the lathe, with a nut which was attached to the sliding part, or carriage. This had been preceded, probably, by other means of moving the carriage for plain turning, such for instance as the old time "chain feed." The "master screw," "traveler screw," or "lead screw," as it was variously called, was for a long time placed at the back of the bed and in the earliest examples was revolved by gearing made by inserting pins in the face or in the edge of wheels or disks. It is altogether probable that for a long time only one pitch of thread was cut by a "master screw," and that when another pitch had to be cut another "master screw" was required, as the "master screw" revolved at the same rate of speed as did the head spindle of the lathe.

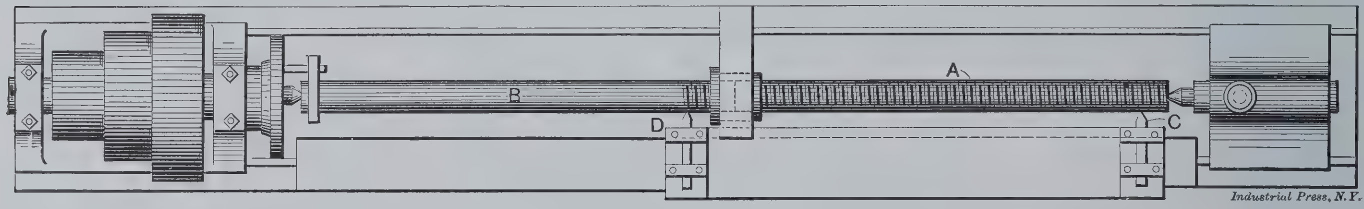


Fig. C. Early Method of Cutting Threads.

Then followed the idea of revolving the "master screw" at a different rate of speed from that of the spindle for the purpose of cutting a different pitch of thread from that of the "master screw." When this was once done, it was easy to see that if two pitches of thread could be cut with one "master screw," any other number of threads might be cut by similar means. In order to cut both right- and left-hand threads, as well as to conveniently bring the change gears into engagement with each other, the stud plate (or "quadrant," "swing plate," "yoke plate," etc., as it has been variously called), was devised, with its stud for idle gears and an extra stud for the gear necessary for reversing the motion of the lead screw in cutting left-hand threads. Thus the well known change gears and adjustable stud plate came about and did good service for many years. But the restlessness of mechanics and the ever-present desire for improvements in time led investigating workmen to look for some method by which to avoid even the small labor and inconvenience of changing the gears when a different thread was to be cut.

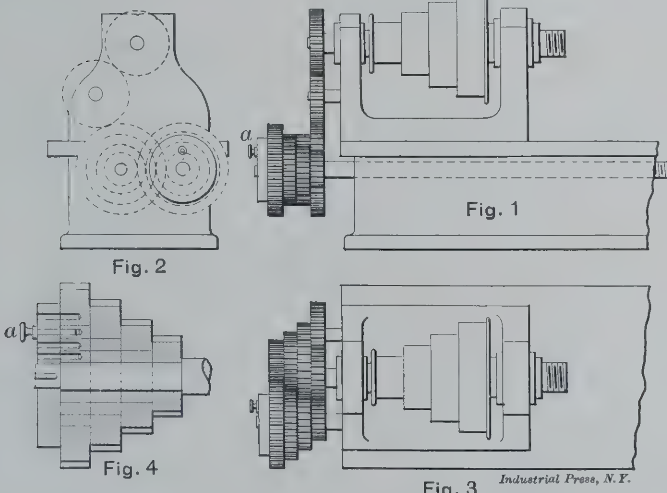
In order to illustrate some of the earlier forms of lathes the one on the first page is shown. This lathe was probably built about 1830 and was the property of an old Scotch mechanic named Rea, who had a shop about four miles from Plattsburgh, N. Y. The bed was composed of two oak timbers about 5 x 12 inches, bolted to wooden legs, as shown. On the inside of each timber a rabbit was cut, in which were fastened flat bars of wrought iron, set with the edges up, and about ⅝ x 3 inches, the upper edges being chipped and filed to answer for Vs. The head stock was cast with pockets of square form for the boxes, which were fitted by filing, and also had threaded studs of wrought iron cast in the head for holding down the caps over the boxes. The boxes were cast of some sort of a composition resembling babbitt metal. The spindle was of wrought iron and carried a wooden cone of three steps built upon a cast-iron flange keyed to the spindle. The tail stock was very light and had on the rear end of its spindle a downwardly projecting part, slotted to receive the tail screw, which was provided with a crank forged upon it. Both head stock and tail stock were held in place by a single bolt each, passing down through wooden binders (not shown in the cut). The carriage was fitted to the same Vs as the head and tail stocks and had no more pretence to an apron than a bracket carrying a cast-tooth pinion meshing in a cast-tooth rack screwed to the front of the bed. The carriage was held down by a cast-iron weight as in all the old style of "weighted carriage" lathes. A power feed was provided for by the use of a chain passing over two grooved wheels in which were pins for engaging the links of an ordinary "log chain." This was operated by a worm wheel with cast and chipped out teeth and a worm of only two or three turns of thread. This was driven by grooved cone pulleys carrying a half inch round hand-made leather belt. To stop and start this feed the end near the cone pulley was journaled in a pivoted box, and the other end supported in a vertically sliding box operated by a wooden lever which was conveniently hooked under a spike driven into the front of the bed. This feed mechanism was said to have been a comparatively recent addition to the lathe.

When the writer saw this lathe along in the beginning of the civil war it had an arrangement of change gears with cast teeth somewhat like the more simple lathes of to day so far as its action was concerned; but hanging on the wall in the old shop and carefully treasured as relics of bygone days were the old "pin gears" and "lantern pinions" shown in the engravings. It was noticeable that one of these "lantern pinions" (the lower one in the engraving), was much longer than the other. This was probably to accommodate different sizes of "pin gears" on the lead screw so as to cut varying pitches of threads.

This lathe was in practical use in 1875, and as its old-time Scotch owner quaintly remarked, it was "able for monny a guid turn yet."

Recurring now to the gradual development of the lathe in reference to the thread cutting problem by the interchange of gears for producing varying pitches, and finally without removing or replacing "change gears," we come to the consideration of the actual evidences of what has been done, and the legal proof of the same as shown by the records of patents in the United States Patent Office. In reviewing the mass of drawings, specifications and claims on these various points, covering the changes invented and proposed, we find many which are for the purpose of changing the rate of *feed* for ordinary turning, and these have been omitted as not properly concerned in the subject of "The Evolution of the Change Gear."

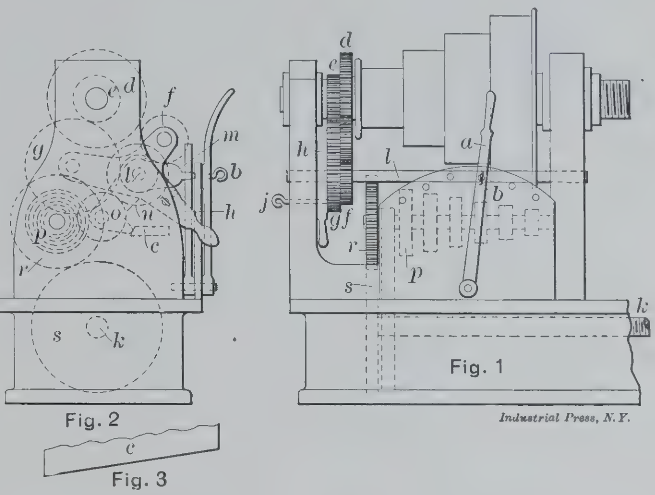
In presenting the drawings of patents to illustrate these articles, it will be noticed that they are in the form of diagrams only, showing in a condensed manner the prominent features of the invention. In some cases as many as four sheets of drawings are here shown in three or four views, for the purpose of simplifying the matter and economizing space. Gears are represented in side elevation by circles of heavy dotted lines and shaded to show their convex surface where the edge view is presented.



Industrial Press, N.Y.

Edward Bancroft and William Sellers. No. 10,491, Feb 7, 1854.

So far as we have any Patent Office records of the matter, the first serious attempt made to assemble all the change gears on one shaft appears to have been made by Edward Bancroft and William Sellers, of Philadelphia, Penn., who obtained patent No. 10,491, which was dated February 7, 1854. They placed the change gears directly upon the lead screw, the first or smallest gear having formed upon it a sleeve bored to fit the lead screw, and having fitted upon it the next gear having a like sleeve for the following gear, and so on. These gears were all held in place by a disk fixed to the lead screw Either of these gears could be in turn fixed to the disk by a pin passing through them both. The arrangement in connection with the lathe is shown in the accompanying illustration, in which Fig. 1 is a front elevation; Fig. 2, an end elevation, and Fig. 3, a plan of the Bancroft and Sellers lathe. Fig. 4 shows the manner of forming the gears with telescoping sleeves, and the fixed plate with its removable pin *a*, for bringing any desired gear into action. The first claim of these pioneers in the change gear problem is worthy of careful consideration. It is as follows: "The method of varying the motions of the mandrel and screw-shaft or leader by means of two series of wheels, each series consisting of wheels of different diameters, and all the wheels of one series being connected and turning together, and imparting motion to all the wheels of the second series with different degrees of velocity, substantially as described." It will be observed that this claim practically anticipates several of the later devices which have been popularly supposed to be the first of the kind, and whose inventors have been given credit accordingly.

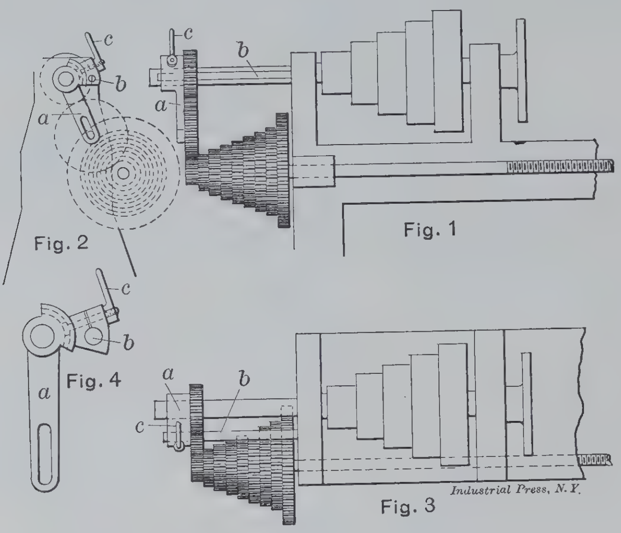


Industrial Press, N.Y.

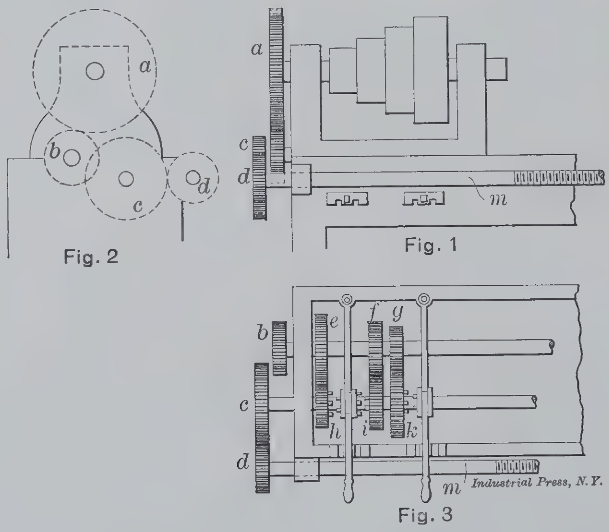
John Humphreys. No. 83,774, Nov. 3, 1868.

John Humphreys, of Chicopee, Mass., was apparently the next inventor who added much to the then "state of the art" as disclosed in his patent No. 83,774, which was granted November 3, 1868. He appears to have followed Bancroft and Sellers in the idea which years later became so popular, for he says: "I place my gear wheels all on a shaft, ranging from the smallest to the largest, leaving a space between them of about the same width as the wheels themselves." This space was provided so that his connecting pinion journaled in a "traveler" as he calls it, and could relieve itself from engagement with one gear before it came in contact with the next, as he had not provided for throwing it entirely out of gear before moving it laterally, as was done later. Another feature apparently original with him, was that of obtaining an additional series of pitches by means of a yoke, pivoted on the same secondary shaft that his traveler worked upon, and having two idle gears journaled upon it, by which either a small gear or one double the size could be quickly brought into engagement with the gear on the secondary shaft. Both these essential features of Humphreys' patent have figured extensively in most of the later efforts in the attempt to provide for rapid changes of feed or from one pitch to another through a large number. Fig. 1 is a front elevation of his lathe head, showing the shifting lever *a*, held at the desired point by the pin *b*. Fig. 2 is an end elevation showing the essential features. Fig. 3 is a development of the cam-shaped rack *c*, which held the traveling pinion in contact with each gear of the cone of gears as it came into mesh with it. The arrangement for multiplying or reducing the speed by gears of double the number of teeth is shown at *d*, *e*, *f*, *g*, journaled upon studs fixed in the yoke *h*, held in either position by the pin *j*. The lead screw *k* was placed within the bed. Upon the shaft *l*, both the yoke *h* and the sliding lever *m* are journaled and the connecting pinion *n* is splined. The pinion *o* connects with the cone of gears *p*, from whose shaft *q* the gear *r* engages the gears on the lead screw *k*.

Three years after Humphreys' patent Frederick B. Miles, of Philadelphia, Pa., in patent No. 111,859, granted February 14, 1871, came still nearer to solving the problem by mounting all his change gears on the lead screw. The end of the head spindle projected far enough beyond the rear box to carry a sliding gear controlled by a "traveler" as Humphreys called it, and having journaled on it an idle gear that might connect the sliding gear with any one of the change gears, at will. It was held in place by being clamped to a rod fixed in the head stock and parallel to the head spindle. He also provided on the lead screw a gear much larger than the change gears for use as a feed gear for a turning cut, there being no feed rod provided for. A front elevation is given in Fig. 1; an end elevation in Fig. 2; a plan in Fig. 3, and a detail of the bracket carrying the connecting pinion in Fig. 4. It is not likely from the construction that it was practical, as the torsional strain caused by the pressure of the gears of the cone of gears and the pinion on the head spindle with the connecting pinion would probably have wrecked the device in a short time. But the *idea* was evidently there and only needed developing in a practical manner. The drawing is so simple that it is only necessary to specify that the sliding bracket or arm seen in Fig. 4 is shown in position at *a*, Figs. 1, 2, and 3, and the supporting rod to which it is clamped is shown at *b*. This arm is secured in any desired position by the clamping lever *c* and its bolt.



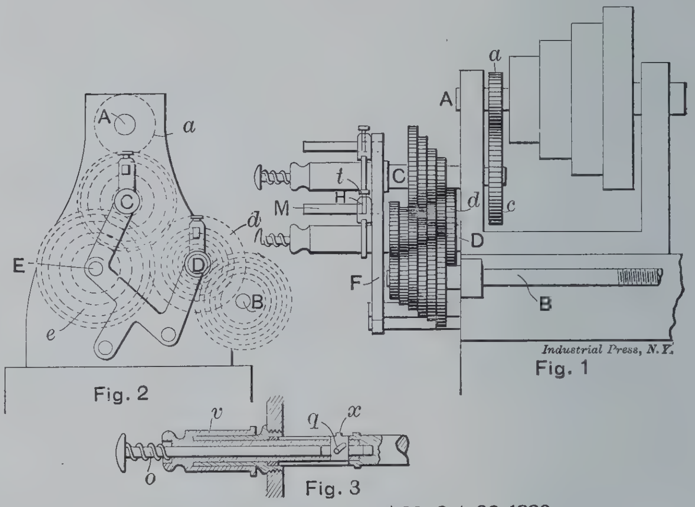
Frederick B. Miles. No 111,859, Feb. 14, 1871.



William Bley. No. 156,753, Nov. 10, 1874.

William Bley, of Reesville, Pa., was the next man to record his ideas in the patent office. He did not add much to the subject, his modification being that of providing two supplementary shafts, upon each of which is mounted a set of change gears in reversed order. One set was fast to the shaft, while the other set ran loose on the shaft and was in turn brought into action by a series of clutches splined to the shaft, each clutch serving for two gears. In this way about three and a half feet of space inside of the bed would have been required for a twenty inch swing lathe. In the drawings, Fig. 1 represents a front elevation of the lathe; Fig. 2 is an end elevation, and Fig. 3 is a plan of the bed showing the arrangement of the supplementary shafts, gears, clutches and the operating levers. The gears *h*, *i*, *k* run loose on their shaft and are connected with it as desired by the adjacent clutch. The gears *e*, *f*, *g* are fast to their shaft and are, of course, each driven by its opposite gear whenever the clutch is thrown into engagement. The driving power to the lead screw is transmitted through the gears *a*, *b*, one of the gears *e*, *f*, *g*, and their fellows *h*, *i*, *k*, and the gears *c* and *d*. In an operative lathe there would need to be many more gears, as the arrangement shown would cut but three different pitches and two more gears would need to be added for each pitch. This would be an elaborate arrangement and scarcely practical, as may easily be seen.

Charles William Riley, of Knoxville, Tenn., next tackles the change gear problem, and the results of his efforts are elaborately shown in the three sheets of drawing of Patent No. 233,702, granted October 26, 1880. If Humphreys had *one* set of change gears arranged in conical form, and Bley had *two*, Riley seems to have been determined to outdo them both by providing *four*, aggregating in all twenty-four gears, by which he could cut fifteen different pitches. He makes this somewhat remarkable statement: "In a planing machine it has been proposed to use two intermeshing series of gear wheels, the wheels of one series running loosely on their spindle, and capable of being individually connected thereto at will." It does not seem that the proposed plan ever came into general use. Another statement in this specification is of more importance. It is this: "I am aware that it is not new to construct a feeding mechanism of two series of intermeshing gear wheels, the wheels of one series fixed to their shaft, and the wheels of the other series revolving loosely upon, but capable of being individually keyed to their shaft." Fig. 1 is a front elevation and Fig. 2 is an end elevation of this device, while Fig. 3 is a longitudinal section of the arrangement for operating the locking keys. In this part of the device the sleeve *v* may be moved in or out so as to bring the key *x* into engagement with any one of the series of gears. When in the proper place the key *x* is forced in or out by the rod *o*, in which is fixed the pin *q*, operating in an inclined slot for that purpose. The sleeve *v* is held in any desired position by means of the sliding arm *H*, traveling upon the square bar *M*, to which it may be fixed by the pin *t*, fitting into one of a series of holes in the bar *M*. The device at *C* is of the same construction and operation. Motion is transmitted from the gear *a*, on the head spindle *A*, through the gear *c*, the cones of gears on shafts *C* and *E* to the gear *e*, thence through the gear *d* to the connecting cones of gears on the shaft *D*, to that on the lead screw *B*. While this device would no doubt accomplish what it was designed for, it seems much too complicated for convenient use or long wearing qualities.



Charles W. Riley. No. 233,702, Oct. 26, 1880.

The patent of Andrew Hyde, of Hatfield, Mass., which was granted October 4, 1881, and is numbered 247,764, appears to be in the nature of a combination of the ideas of Humphreys as to the "traveler" with its sliding pinion and that of Miles, with his cone of gears, placed closely in contact with each other. In fact the sliding pinion arrangement is the same as that adopted by Miles except that his method of locking it is different. The driving is effected through a stud or head shaft connected by gears within the head as some lathes are now constructed. There is nothing really new about it except the method of locking the sliding pinion bracket. His idea of arranging the set of gears in the form of a double cone, with such gears as cut even pitch threads on one end and those which cut odd pitches on the other could hardly be classed as an invention. The result did not mark any distinct step in advance. Fig. 1 is a front elevation and Fig. 2 is an end elevation of this device. The sliding frame or traveler *K*, carries the gears *G* and *L*, journaled in it, the former splined upon the head shaft *I*. By this means the motion is communicated from the head gears *a*, *b*, *c*, to any one of the gears of the double cone, and held in position by the clamping screw *o*, whose lower end rests in one of the recesses in the bar *R*. One difficulty of this arrangement would be the crowding together of the gears when the lathe was running one way and the strain to force them apart when its motion was reversed. Probably the noise produced by such an arrangement of gears would be anything but pleasant. The long overhang of this double cone of gears would be very objectionable.

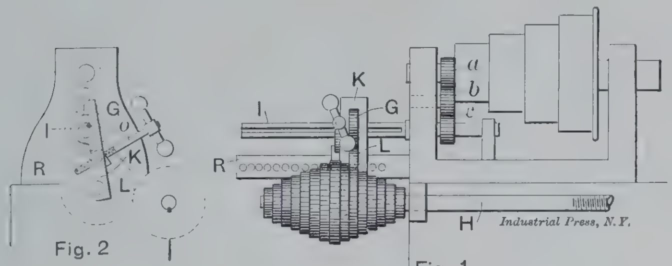


Fig. 2

Fig. 1

Andrew Hyde. No. 247,764, Oct. 4, 1881.

Patent No. 252,760, dated January 24, 1882, and issued to George A. Gray, Jr., of Covington, Ky., relates to the method of arranging the usual change gears, in which the stud plate is pivoted upon the stud or head shaft and carries always the same idle gears. The lead screw having a four-pitch thread and the change gears varying by six teeth each from 12 to 72, and the stud gear having 24 teeth, made a convenient arrangement; and changes were made by removing one gear only and replacing it by another, the stud plate being adjusted accordingly. This saved the changing of the idle gear, and cut threads from two to twelve per inch. In the drawings, Fig. 1 is a front elevation, and Fig. 2 is an end elevation of the device, while Fig. 3 shows the stack of change gears which were used upon the lead screw *C* only. The arrangement of the stud plate *R*, journaled upon the head shaft and held at any desired point by a clamping bolt, is in the ordinary manner. While the inventor did not avoid taking off a gear and substituting another for each different pitch, it was probably a more satisfactory and practical arrangement than some of the more complicated and pretentious devices, and no doubt served a good and useful purpose.

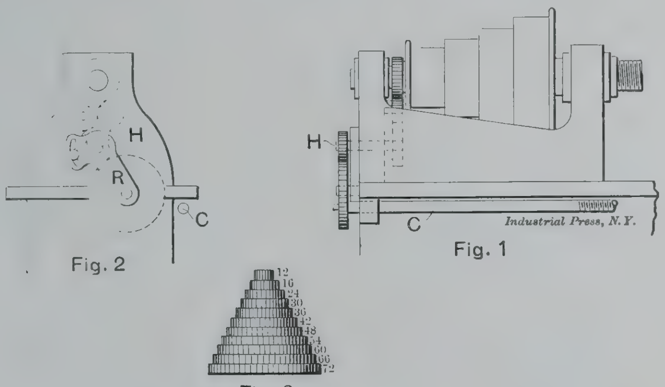


Fig. 2

Fig. 1

Fig. 3

George A. Gray, Jr. No. 252,760, Jan. 24, 1882.

The ear-marks of a practical mechanic are quite visible in Patent No. 462,481, granted November 3, 1891, to Joseph Flather, of Nashua, N. H. In this case instead of one fixed feed gear on the main spindle of the lathe, three or more gears of varying sizes are fixed thereon. On the head shaft or stud are the same number, and of corresponding sizes loosely fitted and adapted to be engaged individually by means of a sliding rod and pin, the stud being made tubular for that purpose. A simple and effective arrangement of driving the feed rod is provided, which does not affect the subject herein discussed. In the drawings, Fig. 1 shows a front elevation of the invention, and Fig. 2 is a longitudinal section through the cone of gears on the head shaft. Upon the head shaft or stud *a* and upon the lower lead screw *L* are fixed and operated, change gears in the usual manner, except that the value of each change gear in screw cutting is multiplied by the number of feed gears on the head spindle. So that while Riley, for instance, used twenty-four gears to cut fifteen threads, Flather needs but eleven, or less than half the number. The gears *d*, *e*, *f*, on the head shaft are arranged as shown in Fig. 2. The center gear *e*, being of necessity bored entirely through at an enlarged diameter to accommodate the sliding pin device, is held in position concentrically by a projecting ring formed upon it and fitting into a suitable annular recess in the gear *d*. The gear *f* has a clutch member extending into the gear *e*. The operating rod, *p*, carries a pin, *q*, which engages the clutch member of either of the three gears as desired.

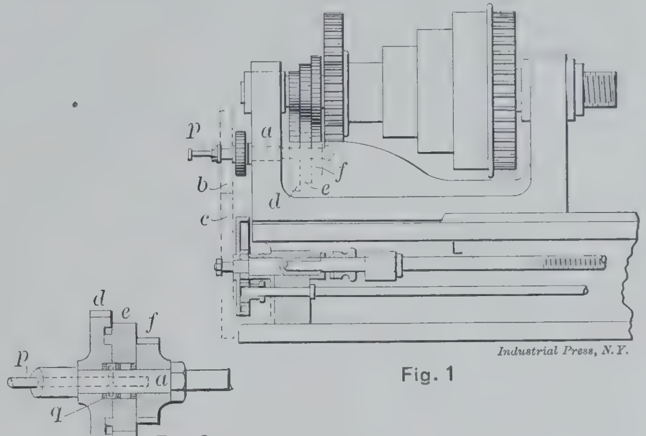


Fig. 1

Fig. 2

Joseph Flather. No. 462,481, Nov. 3, 1891.

On February 2, 1892, Peter and William Shellenback, of Richmond, Ind., were granted Patent No. 468,183. These inventors fix a cone of gears on a sleeve splined and sliding upon a driving shaft located within the bed, and moved to any position desired by a pinion whose teeth engage with a series of grooves turned in a projecting end of the sleeve, forming in effect a rack. This pinion is fixed upon a shaft projecting out at the front of the head, where it is controlled and held in position by a lever provided with a spring pin adapted to enter any one of the holes in a fixed segment. Journaled upon an intermediate shaft located in the head above the driving shaft are the usual driving pinion and an intermediate pinion journaled on a swinging arm operated and held in position by a shaft and pinion engaging teeth cut on a segmental portion of it. This pinion is fixed upon a shaft which projects outside of the end of the bed, where it is operated and held in position by a lever swinging over a segment

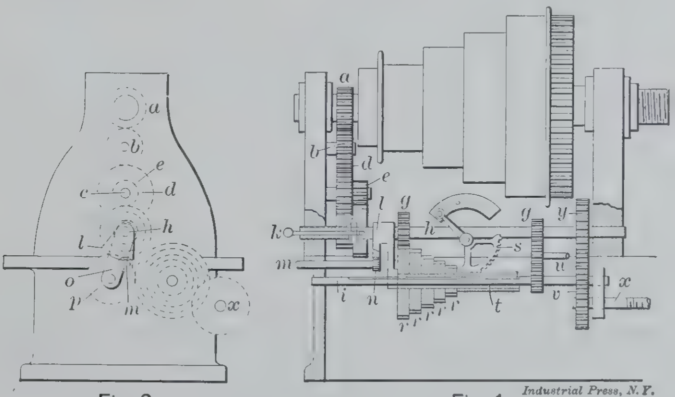


Fig. 2

Fig. 1

Peter and William Shellenback. No. 468,183, Feb. 2, 1892.

and provided with a spring pin which enters any one of a series of holes in the segment. The peculiarity of this arrangement is that instead of the usual "traveler" with its two pinions for connecting the shaft upon which it slides to any one of the series comprising the cone of gears, the cone of gears itself slides bodily to any one of the required positions. Among other things the inventors say: "In many kinds of work it is desirable that the carriage should move in one direction while the tool is cutting, and when the tool is withdrawn from the work it should return to the starting point to enable the tool to make a fresh cut." Perhaps we ought to be grateful for this information. In the drawings, Fig. 1 is a front elevation, showing the bed and a portion of the head in vertical section, and Fig. 2 is an end elevation. Power for driving the lead screw is transmitted from the head spindle through the gears *a*, *b*, to a fixed stud *c*, having journaled upon it the two gears *d*, *e*, which are fixed to each other and mesh into the gears *f*, *g*, on a supplementary shaft *h*, to which either may be connected by a sliding key operated by the rod *k*. Upon the shaft *h* is fixed the toothed segment *l*, which is operated by the shaft *m*, having the pinion *n* formed upon it. Fixed also to the shaft *h* is the arm *o*, having journaled to a stud fixed in it the connecting gear *p*. This is continually in mesh with the gear *q*, fixed to the shaft *h*, and capable of being brought into engagement with any one of the cone of gears fixed upon a sleeve splined to the shaft *i*, as they are brought opposite to it by the action of the toothed segment *s*, engaging in the grooves of the sleeve *t*, to which the gears *r*, *r*, *r*, *r*, are fixed. Motion is communicated from the shaft *i*, through the gears *u*, and *v*, to the lead screw *x*. Motion may also be communicated by way of the gear *g*, without bringing the cone of gears into use.

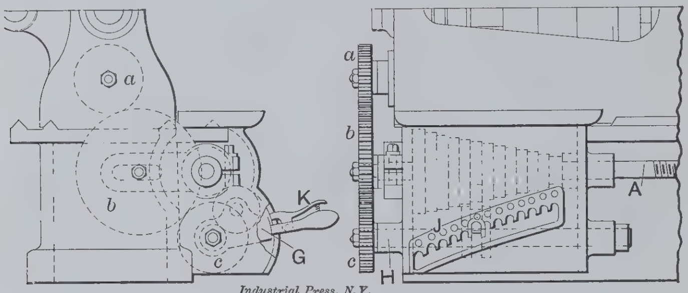


Fig. 2 *Industrial Press, N. Y.* Fig. 1

Wendel P. Norton. No. 470,591, March 8, 1892.

We now come to a patent which has probably caused more interest and discussion on this subject than any one previous to its issue. It is No. 470,591, and was issued March 8, 1892, to Wendel P. Norton, then of Mount Vernon, N. Y., but later of Torrington, Conn. It contains some of the good ideas of the earlier inventors, now brought into good mechanical form and combination for producing practical results. Humphreys in 1868 introduced the cone of gears. They are here. He wrote: "I place my gear wheels all upon a shaft *A*, ranging from the smallest to the largest." Norton says: "On the shaft *A*, and within the box *B*, are secured a series of gear wheels *E*, of varying diameters, arranged step-like," etc. Humphreys placed his gears a little more than the width of the face apart. Norton places his close together, like Miles in 1871 and Hyde in 1881. The clumsy arrangement of Humphreys' "traveler," Miles' "movable swinging arm" and his "shifting clamp," and Hyde's "sliding frame," is replaced by a compact and well-arranged sliding, forked lever, carrying the connecting pinion. Altogether it is a good example of how the crude efforts of early inventors may be, by the present advanced state of mechanical knowledge, put into practical and useful combination. In the drawings, Fig. 1 is a front, and Fig. 2 is an end elevation of this device. Motion is communicated from the head spindle by way of the usual head shaft and the gears *a*, *b*, *c*, to the supplementary shaft *H*, upon which is fitted the sliding arm *G*, the latter carrying a gear splined to the shaft *H*, and also the connecting pinion *F*, journaled in it, and capable of connecting with either of the gears *E*, *E*, *E*, etc., on the shaft *A*. This sliding lever *G*, is conveniently arranged with a handle, and a thumb-lever *K*, having formed upon it a pin entering any one of the holes in a fixed plate *J*, its position first being readily located by a series of notches in the lower edge of the plate into which a portion of the lever *G*, enters. The pin on the lever *K*, finally secures it accurately in place. The device has been for several years in practical use in many shops in this country.

There is nothing especially noticeable in the effort of William Shellenback, of Richmond, Ind., who on April 10, 1894, obtained Patent No. 518,164, for his device, in which he placed a cone of gears on a shaft within the bed and applied the much-used traveling pinion to connect its different gears with the driving shaft above it. In the drawing, Fig. 1 is a side elevation, and Fig. 2 is an end elevation of the device. A yoke plate *e*, carries a stud upon which are journaled the flanged gears *c*, *d*, which may thus be brought into action by sliding them upon the stud, their flanges retaining them in place. By this means a second series of speeds produced by the cone of gears is obtained. The shifting lever *g*, is journaled upon the supplementary shaft *f*, and has journaled upon a stud fixed in its lower end the connecting gear *h*, by which the gear *i*, on the supplementary shaft *f*, is connected at will with any one of the gears *k*, *k*, etc., of the cone of gears splined to the supplementary shaft *L*, which is connected with the lead screw *M*, by a short transverse shaft extending through the front of the bed and operated by miter gears. While the space within the bed affords plenty of room in which to place any number of gears and their necessary appendages, and while they are out of the way more than if placed in front of the bed, the device has the disadvantage of being difficult to get at in case of accident, and until we can do much better in our designs and workmanship, and have a higher grade of operatives to attend them, accidents will sometimes occur to the best constructed machinery.

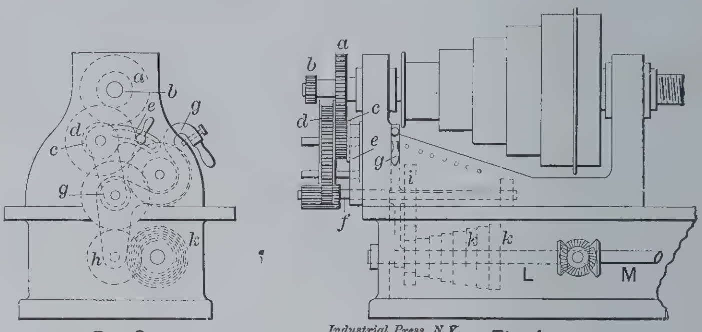


Fig. 2 *Industrial Press, N. Y.* Fig. 1

William Shellenback. No. 518,164, April 10, 1894.

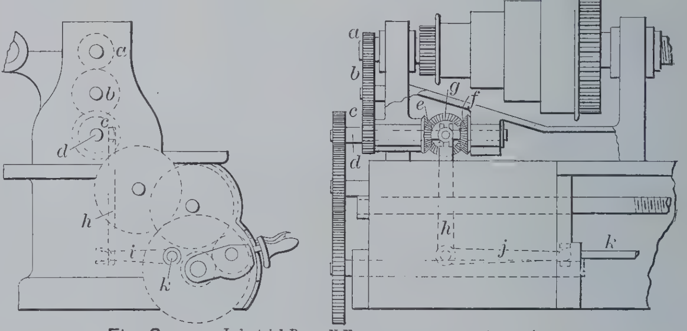


Fig. 2 *Industrial Press, N. Y.* Fig. 1

Wendel P. Norton. No. 519,924, May 15, 1894.

The second patent of Wendel P. Norton, viz., No. 519,924, granted May 15, 1894, was not properly for change gears, but intimately connected with them inasmuch as it was for a compact and well-devised method of reversing the motion of the change gears by means of three miter gears located within the lathe head and conveniently operated by proper levers and a reversing rod worked from the lathe apron, thus forming an automatic stop. In the drawings, Fig. 1 is a front, and Fig. 2 an end elevation, a portion of the head being shown in vertical section in Fig. 1 for the purpose of more clearly showing the reversing device. Power to operate the lead screw through the medium of the device shown in his Patent No. 470,591, is transmitted from the head spindle through the gears *a*, *b*, *c*, to the head shaft *d*, which has loosely journaled upon it the miter gears *e* and *f*. Both of these gears are in mesh with a third miter gear *g*, located in their rear and journaled upon a fixed stud. Between the miter gears *e* and *f*, there is a clutch splined upon the head shaft *a*, Fig. 2, with clutch members formed on each face and adapted to be engaged with similar clutch members formed on either of the miter gears *e* and *f*. This clutch is operated by the levers *h*, *i*, *j*, and the tumbling rod *k*. This device is really a continuation, or rather perhaps the completion of the device shown in the former Norton Patent No. 470,591, so that he accomplishes, not only a great number of changes, but also reverses them at will or automatically.

* * *

RECOLLECTIONS OF AN ENGLISH MACHINE SHOP.

C. VICKERS.

Twenty-five years ago I made my first attempt to learn a trade in the machine shop of one of the largest engineering works in the Eastern counties of England. I was then a boy of 14, and had decided to become a fitter, chiefly because the word "fitter" sounded better to my ears than "turner." Machinists in those days in England—and probably now—were known either as "fitters," "turners," or "erectors," the word "machinist" not being used. A fitter was a vise hand; a turner, a lathe hand, and an erector assembled the different parts and built the machine. So I was provided by my parents with the regulation white overalls and jumper of the machinist, and started to work in the turning gallery.

The turning gallery was a balcony which extended around the walls of the big machine shop at a height of twelve or fifteen feet. This gallery was filled with lathes and other machines, all operated by apprentices. The one I was put at was for the purpose of facing the heads of bolts, and rounding off the ends of studs. It consisted of a cone pulley and a chuck with changeable jaws to accommodate the different diameters of the bolts, etc. The spindle was hollow, about four inches in diameter and cut away on two sides to enable operator to insert his hand and forearm when changing the jaws of the chuck, which were in three segments and were tightened by a nut through which they protruded slightly.

To turn a stud, the jaws were opened by loosening the nut, with a huge spanner, then the stud was pushed in and the spanner shifted onto the hexagonal part of the nut, its long handle resting against the lathe bed—which held it from turning. The power was switched rapidly on and off, and the momentum of the lathe ran the nut up with a jerk, when the spanner was shifted onto the circular part of the chuck, where it rested while the machine was in motion.

There were over a hundred boys working in the gallery, all learning to be turners, fitters, or brass-finishers, and they were promoted at regular intervals, and in their turn. There was an established schedule of wages, based on the boy's age, with a regular annual increase for five years when the boy was "out of his time."

As was natural among so many boys, there was much practical joking when the foreman's back was turned and many a protest reached him from indignant machinists down below, who had been pelted by metal or "soaked" by greasy waste. But it was useless to try to discover the offender, because the greatest crime any boy could commit was to "split" against his fellows. The foreman knew this, but once in a while he would give the boys a lesson. One day, just before the bell rang, some one threw a hammer across the gallery. It missed its object (luckily, perhaps) and struck a gas fixture, breaking it off short. When the foreman saw it he went to the boy nearest the wreck, and asked him if he knew who threw it. "Yes," was the answer, "but I won't tell." As the foreman expected this he said nothing, but just handed him his discharge slip, then passed to the next boy with the same question and got a similar answer, and inside of five minutes there were a half dozen boys stringing out to the timekeeper's office.

Having depopulated that corner of the gallery the foreman desisted from his inquiries, and the real offender escaped, although I have known cases where he nobly came forward and confessed to save his shopmates their jobs. Such a boy was considered a hero, but as he was promptly cut off from the scene of his self-sacrifice his fellows never had an opportunity to show him their appreciation of his conduct. So, as the boy with a conscience got all the bitter with none of the sweet, such conduct was not exactly looked for.

This establishment manufactured "threshing machines," portable and stationary engines, locomotives, pumps, traction engines, and steam dredges or "navvies," as they were called. There were four or five other such firms in that city, each employing from 1,200 to 2,500 men, and the rate of wages, hours of labor, and general shop rules were identical in each. Fifty-four hours constituted a week's work, and over that (up to 64 hours a week) was paid at the rate of time and a quarter; all overtime over 64 hours, time and a half. In times of prosperity these works ran overtime for years at a stretch and when adversity came, the hours were shortened and the men paid accordingly.

Work was commenced in the morning at six o'clock and continued until eight, when a half hour ("breakfast time") was given; dinner hour was from 12:30 to 1:30 P. M., quitting at five o'clock, for four days—one day having ten, and Saturday six hours. Each man on entering the company's employ was furnished with three brass checks, with a number stamped thereon. The works were opened in the morning at fifteen minutes to six, and the employes had to file through a corridor, on one side of which was a long window, behind which sat the timekeepers. The window sill, a narrow ledge, was just high enough for a man of ordinary size to rest his elbow on; it was brass covered, and a slot ran longitudinally from end to end. This slot was just wide enough to admit a check, and as the men passed on, they slid their hands along the sill and dropped in their check, and the action after awhile became mechanical so that it was rare that anyone forgot to register.

At the stroke of six the slot was closed, and all who missed putting in their checks had to lose a quarter of an hour. They were given another chance to get in from 6:10 to 6:15 A. M., after which they were "half-houred," the slot being again open from 6:20 to 6:30.

Then it closed until breakfast time, being open from 8:20 to 8:30. The same chance was given the tardy ones to record their time on the quarter or half hour, both at breakfast time and noon. Thus by noon, the three checks were all in, and before 5 o'clock the check boy came around and again distributed the checks. Every man had to leave the works at meal times, large, comfortable mess rooms being provided for them outside of the works. There were generally two of these rooms—one for smokers, the other for non-smokers. They were furnished with rows of long, heavy, well-scrubbed pine tables, with benches on either side, the men sitting in rows facing each other, every one having a recognized seat.

There were also large ovens for warming the food, and regular attendants paid by the firm, called mess men, attended to this and the other duties of scrubbing, etc.

Tea was the beverage most in favor, and was carried to work by the men, in tin pails and bottles, on which was an identifying tag. They were left in the mess room in the morning, and by breakfast time their contents had been heated and the cans were placed on the first table, past which the men filed and picked out their property.

The Saturday half holiday was religiously observed the year round, no matter how busy the firm might be; work ceased for the week on Saturday noon. Saturday was also pay day, and the paying of 2,000 men in cash occupied less than a half hour. The timekeeper's office had several windows, opening into the yard. At each open window would be stationed two timekeepers, one of whom held a record of the names from which he would read off as the men filed past. After the name was called, the other timekeeper would give the number and as he did so, pass the money—which was inclosed in a small canvas bag, with the number printed thereon—to the workman, who, as he reached for his pay, repeated his number. When anyone missed his turn, he had to wait until the last, when such were called over again. The empty bags were generally returned, as the men passed through the gates, being tossed into a receptacle there for the purpose, although it was allowable to retain them until the following Wednesday. Each department was paid as a whole, the numbers running consecutively.

But my ambition to become a "fitter" was doomed to disappointment. One fatal day, some one ate an orange and used the peel, with the aid of a piece of rubber, to annoy the much-tried workers below. "Tubby," as the portly manager was facetiously known among the men, happening past, saw the effect but not who caused it; he promptly ascended the gallery, and hotly interviewed the foreman, who got revenge for his "calling down" by depopulating that portion of the gallery from which the missiles were supposed to have come. This time I was in it, and went forth from that shop, as others had done, and eventually entered another. But this time it was a foundry, and so it came to pass that the world became afflicted with another molder.

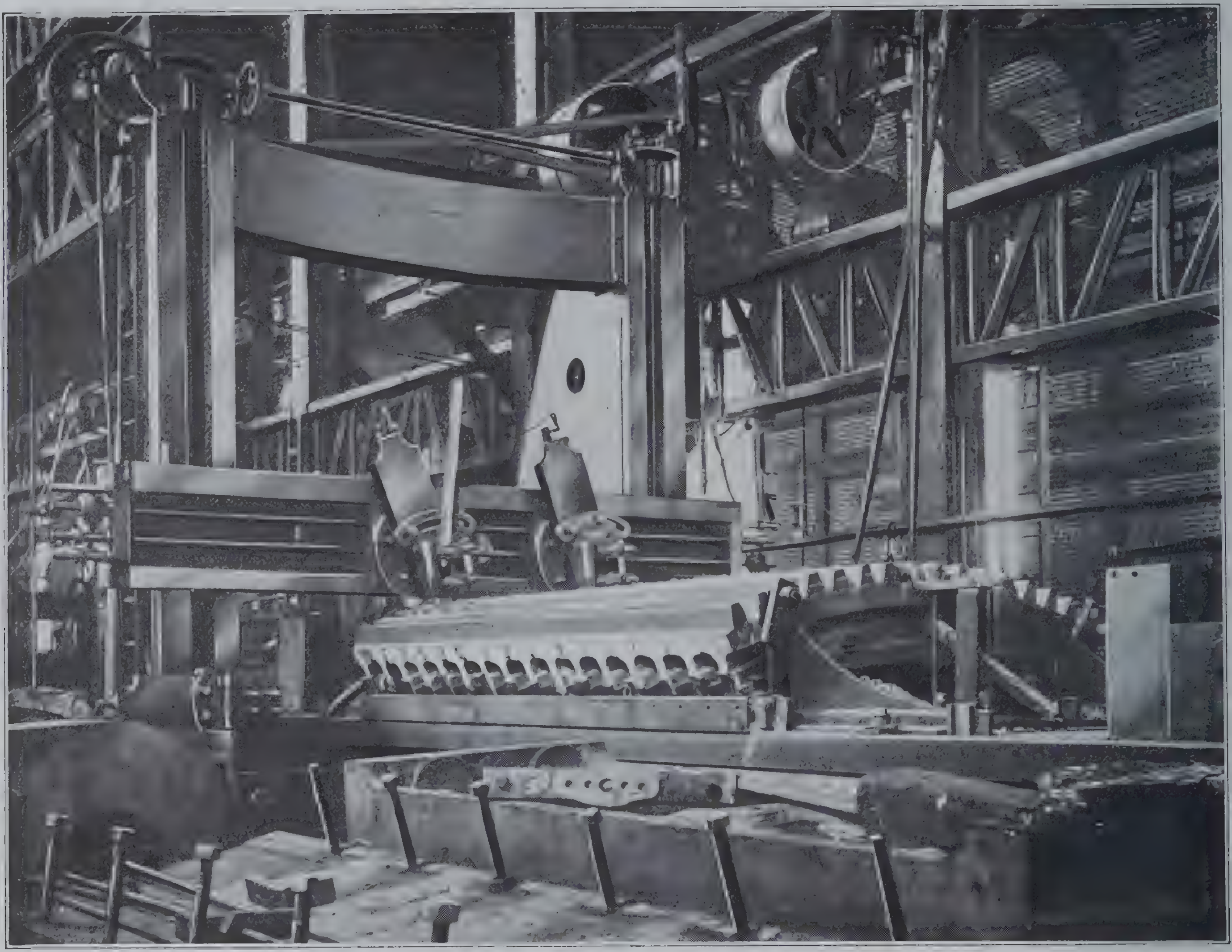


Fig. 1. Planing Gear Teeth in sixteen Segments of a 20 ft. 9.55 in. Diameter Steel Gear Wheel for Ashley Plane, C. R.R. of N. J.

GEAR CUTTING EXTRAORDINARY—A HUGE DRILL PRESS JOB.

While it is by no means a rare job to machine rack teeth on a planer, or even to cut small spur gears in this way, we think that the gear job shown in Fig. 1 is a somewhat unusual one both in the matter of size and in the manner in which it was done. Particularly the latter, since the cutting of spur gear teeth on a planer is ordinarily a tedious and troublesome job unless special fixtures are employed, but in this case, although it was done without special appliances of any kind, the process was one that should compare most favorably in cost with any other that has been devised, and it certainly appears to be the most feasible one to follow in a shop not specially equipped for heavy gear cutting. Especially does this apply when the gear is composed of two sets of segments, arranged side by side, which were so designed that the total number of teeth in one set is an exact multiple of the number in one segment. This made it possible to plane the whole number of segments at one setting.

The gear in question is one being built by the Bethlehem Steel Co. at South Bethlehem, Pa., for the Ashley plane of Central Railroad of N. J. The rim is composed of 16 cast steel segments arranged side and side in two sets of 8 each. The segments are each 8 feet 2 inches long on the pitch circle and contain 16 teeth of 6⅛-inch pitch, making 128 teeth in the circumference. The pitch diameter is 20 feet 9.55 inches; the face width of a segment, 9¼ inches; total width of rim, 3 feet 7½ inches; width of hub, 5 feet 6 inches; diameter of hub, 4 feet 4 inches; total weight of 16 segments shown on planer, 40,960 pounds.

In Fig. 2 is shown the upper half of a cast steel head of a 12,000 ton forging press being built for the Carnegie Steel Co. branch of United States Steel Corporation. This huge casting which is estimated to weigh 250,000 pounds, had been planed at the time the photograph was taken, this operation having been performed on a large pit planer of the type used for planing armor plates. The work does not reciprocate on these machines, the crossrail and heads traveling instead on horizontal ways between which the work is placed in a deep pit. The illustration shows the casting in front of a Bement, Miles & Co. special double drilling and boring machine. This machine has two columns which carry between them a horizontal arm on which are mounted the spindle heads. The horizontal arm may be rotated so as to present the spindles in any desired direction in parallel planes. The spindles can be presented to any part of a vertical plane 17 x 20 feet. In the illustration the work being done is boring out the large bolt holes, one boring bar and the temporary housing supporting the outer end showing at the further side and upper corner.

The dimensions of the steel casting are: Length, 24 feet 4 inches; height, 13 feet 2¼ inches; width, 5 feet 2 inches. A special car has been built to transport the parts of the forging press to Pittsburg. In connection it may be mentioned that the Bethlehem Steel Co. have in their own plant a still larger forging press in the matter of capacity, having the power to exert a pressure of 14,000 tons. The press and 15,000 horse power pumping engine used to operate it were illustrated and described in the October, 1899, issue of MACHINERY.

* * *

NOTES ON FORCED BLAST HEATING SYSTEMS.

At a recent meeting of the New York Railroad Club an interesting discussion took place upon the subject of heating railroad shops and other one-story buildings of the same na-commonly used at the present time in plants of all descriptions.

The distribution of the air by means of pipes should be so carried out that the lower part of the room is kept at a comfortable temperature, while at the same time no disagreeable drafts are produced. It has been found that by properly proportioning and directing the delivery flues most satisfactory results can be secured. Illustrating this point some very interesting examples were cited, at the meeting, by Mr. C. H. Gifford, of the B. F. Sturtevant Co. He said:

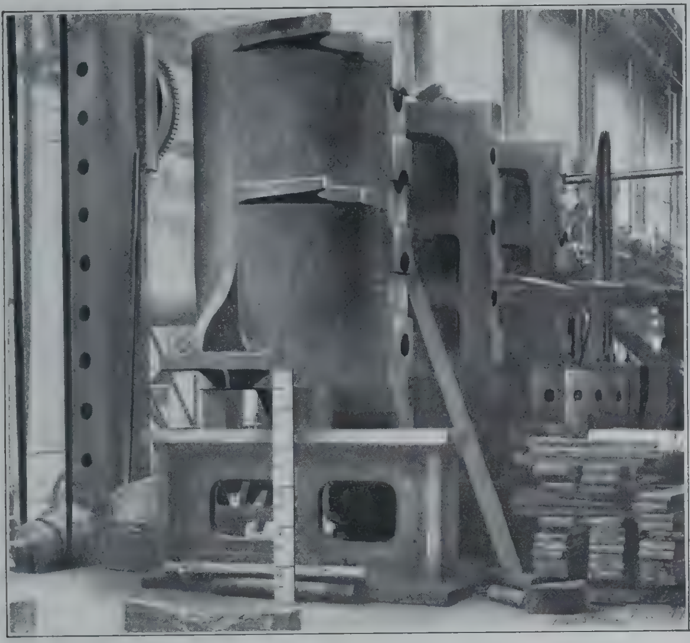


Fig. 2. Boring Bolt Holes in 250,000 pound Steel Casting for Carnegie Armor Plate Press. (See opposite page.)

"In the first place, if you desire air or almost any other form of gas or substance at any particular place at any particular time, the best way is to provide a suitable conduit to deliver it there, and I would add, if there is any difficulty, which there may be, by air blowing on an individual workman, it is a simple mechanical detail to rectify it. If you are unable to predetermine where the men or machines are to be located in a building, you can simply have an adjustable discharge opening from the pipe delivering the air and if, perchance, it blows upon some one, there generally is some space near the person to which the air can be directed and therefore cause no inconvenience whatever.

"As an example of what can be accomplished by distribution, I have in mind a machine shop, that of the New York Shipbuilding Co., which as a machine shop is not dissimilar to one designed for railroad work. They have a building which I believe is about 1,100 feet long, about 250 feet wide and 82 feet high. The proposition was to heat one-half of this building and leave the balance of it unheated. It was a problem that came to me, and I must say that I was a little phased at attempting to heat one end and not have any interference from the other end. We however conceived the idea that there could be a partition put across the middle of the building about 12 feet high. We could then bring the heated air down to the zone which it was desired to heat, which was not over 8 feet above the floor, and in that way we could perhaps confine the air in the space, so as not to have much effect on the rest of the building. It was something of a speculation and rather a bold attempt, when you consider entering into a guarantee which might involve a serious loss; nevertheless it was done.

"The apparatus is arranged under the landing platforms of the gallery which surrounds the shop, so that it is out of the way of the cranes. Pipes are carried along beneath the runway of the cranes and branches are brought down on the posts and discharge the air toward the floor, the outlet being in the form of a Y, which is adjustable.

"We were very much gratified after the plant was started to find that it performed just as was expected it would, and it is surprising to note the difference in temperature between the two sides of that partition; it is almost the same as when you pass from the building out of doors. The result is simply due to the fact that the air was brought down and continually pressed down into the space which it was desired to heat."

Further emphasizing the advantages of correct distribution Mr. Gifford says that it is "possible in some cases to introduce $50 worth of additional pipe to carry the air where it is most needed, so that you can, on account of this, leave out $100 worth of heating apparatus. That is, you can get equal results by using smaller apparatus and less steam."

The adoption of the fan system renders the control of the heating apparatus and of the ventilation ideal. During very cold weather, or in the morning when the building is being heated up, the air supply may be drawn from within the building itself, thus effecting a great economy of heat. In some buildings having a very high cubic space per occupant, sufficient ventilation during the winter time will be supplied by the leakage of air through doors and crevices about the windows by transfusion, etc.

"The pipes for a heating system should be so arranged that the air will not be discharged directly upon the workmen; it is also true that hot air will do the most good if it is put where it is needed. If the space around the walls of a building is properly heated, one may never worry about the center, as that will keep warm.

"We have found, therefore, that most satisfactory heating will result from numerous pipes discharging on the outside walls at a point about 6 feet to 8 feet above, and directed toward the floor. These pipes should be located from 25 feet to 40 feet apart, depending upon the character of the building. This arrangement causes hot air to be blown downward, whence it spreads on the floor, keeping it warm before the air has a chance to follow its natural tendency and ascend to the roof. Hot air has a very bad faculty of getting up in the trusses and if you blow the air directly at the floor and get the floor warm, at the same time keeping the outside of the building warm, your problem is practically solved. In the case of an underground duct, it is well to use short outlet pieces which will discharge along the walls at the floor.

"At the works of the Fore River Ship and Engine Building Co. they have an overhead pipe system with drops on the walls, which was put in according to the regular practice. Later they added 50 per cent. to the building and are now heating it with the same apparatus. That is, we picked out a fan heater which we considered to be the proper size for that particular building and it worked in a perfectly satisfactory manner. Later the ship company added 50 per cent. to the length of the building. We extended the piping and carried drops on the walls every 30 feet, blew the air on the floor with ample outlets on the ends, and in the coldest weather the heat of the building, which is 50 per cent. larger than we would care to guarantee with our apparatus, was perfectly satisfactory to them. Their success is entirely attributed to the excellent system of air distribution.

"At the shops of the Atchison, Topeka & Santa Fe Railway Company, the underground system was adopted and low horizontal outlets were provided which distribute the air at the floor and along the walls. This is an extremely large shop, the contents being about four or five million cubic feet. The shop is heated by four large apparatuses and the underground ducts extend almost entirely around the building. The pipes are not over three feet high, the air being discharged horizontally along the floor, and I understand that the building is very satisfactorily heated.

* * *

Water in freezing, is said to exert an expansive force of about 30,000 pounds per square inch. No wonder that pipes burst!

NEW SHOPS OF THE AMERICAN TURRET LATHE MFG. CO.

The buildings of the new plant of the American Turret Lathe Mfg. Co., Warren, Pa., embody a number of features of more than ordinary interest in shop construction. The view in Fig. 1 shows the plant when nearly completed. The building at the right is the erecting shop and the buildings at the left are for machine work, those in the foreground having a higher roof than those in the background. The power plant is in the small building at the center and a raised passage way, clearly shown in the photograph, is located between the erecting and machine shops to afford room for the large overhead pipes of the heating system, without having to utilize any of the head room of the main buildings for this purpose. It will be noted that all the buildings are of the saw-tooth roof construction.

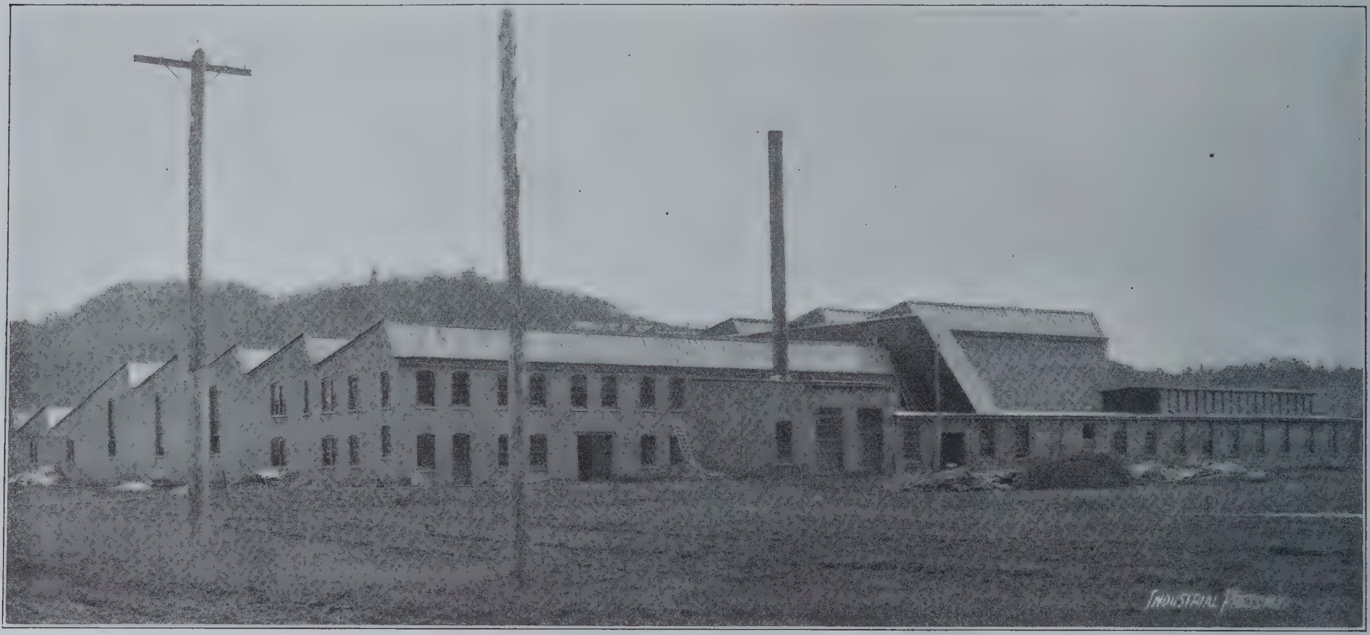


Fig. 1. American Turret Lathe Shops—Note that Saw-tooth Roof Construction is used and that the Buildings are of three different Heights to accommodate different Classes of Work.

In laying out this plant the following considerations were given prominence: First, arranging it in such a way as to permit of a systematic increase without disarranging the original plan of operation. Second, to so design it that the whole floor area should be well lighted and that future additions would not interfere with the light of any part. Third, complete crane facilities, not only in the erecting shop but in the machine shop, wherever required. Fourth, a systematic arrangement of the tools according to the work to be done. Fifth, an electric power transmission along original lines.

With regard to the first of these it will be seen that the buildings may be extended in either direction, maintaining, if desired, the relative proportions between the different departments. To obtain the second condition the saw-tooth form of roof was adopted but an entirely original method of constructing the roof was used, in order to obtain unobstructed room for the numerous cranes that it was desired to install.

Inasmuch as a saw-tooth roof is virtually a flat roof and is built up of short sections, a shop of this construction generally has a great many columns, which interfere with the operation of traveling cranes. Two of the earliest shops of this type were those of the De Laval Cream Separator Co., at Poughkeepsie, N. Y., and the Straight Line Engine Works, at Syracuse, N. Y. The former is used solely for the manufacture of small machine parts, and while it is very well adapted to this purpose it would hardly serve as a model for a concern manufacturing medium and heavy machinery. At the works of the American Turret Lathe Mfg. Co. the majority of the machines built weigh less than 5,000 pounds each, but a considerable number weigh from 10,000 to 20,000 pounds, and an occasional machine weighs much more. This shows the need of the crane facilities.

In the case of the Straight Line Engine Works the spacing between the columns is only 8 feet, while in the erecting shop, where there is a traveling crane, a different type of roof is adopted which allows a free runway for the crane. One of the latest examples of the saw-tooth roof is the fine plant of the De Laval Engine Co., at Trenton, N. J., but this again is of composite design like the Straight Line shops and no provision is made for traveling cranes in the saw-tooth section.

This difficulty is obviated in the shop under description by using a form of truss or girder construction for the support of the roof, which makes it possible to place the columns at a much greater distance one from the other, and gives ample room for the traveling cranes in the machine shop sections.

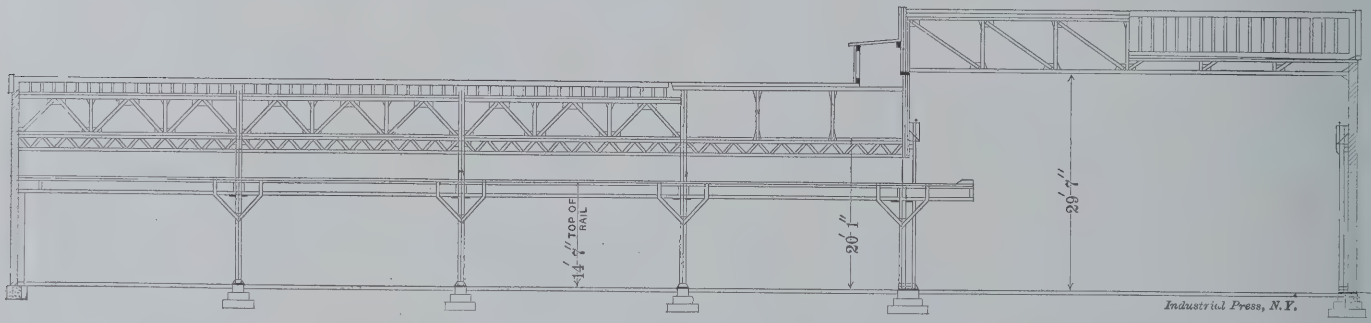


Fig. 2. Showing Girder Construction for Supporting Roof.

By this plan it is not necessary to have any machine tools at all on the erecting floor, which is thus left free for the erection of machinery, without interference from any of the other departments. The runways for the machine shop cranes are at right angles to the tracks of the traveling crane in the erecting shop. In order to transfer the machine parts and castings from the machine shop cranes to the crane in the erecting shop the latter is placed higher than the former and the ends of the tracks of the shop cranes extend into the erecting shop. This allows the crane carrying a piece from the machine shop to deposit it under one end of the crane of the erecting shop, where it may be picked up and transferred to any part of the floor or to any of the other shop cranes.

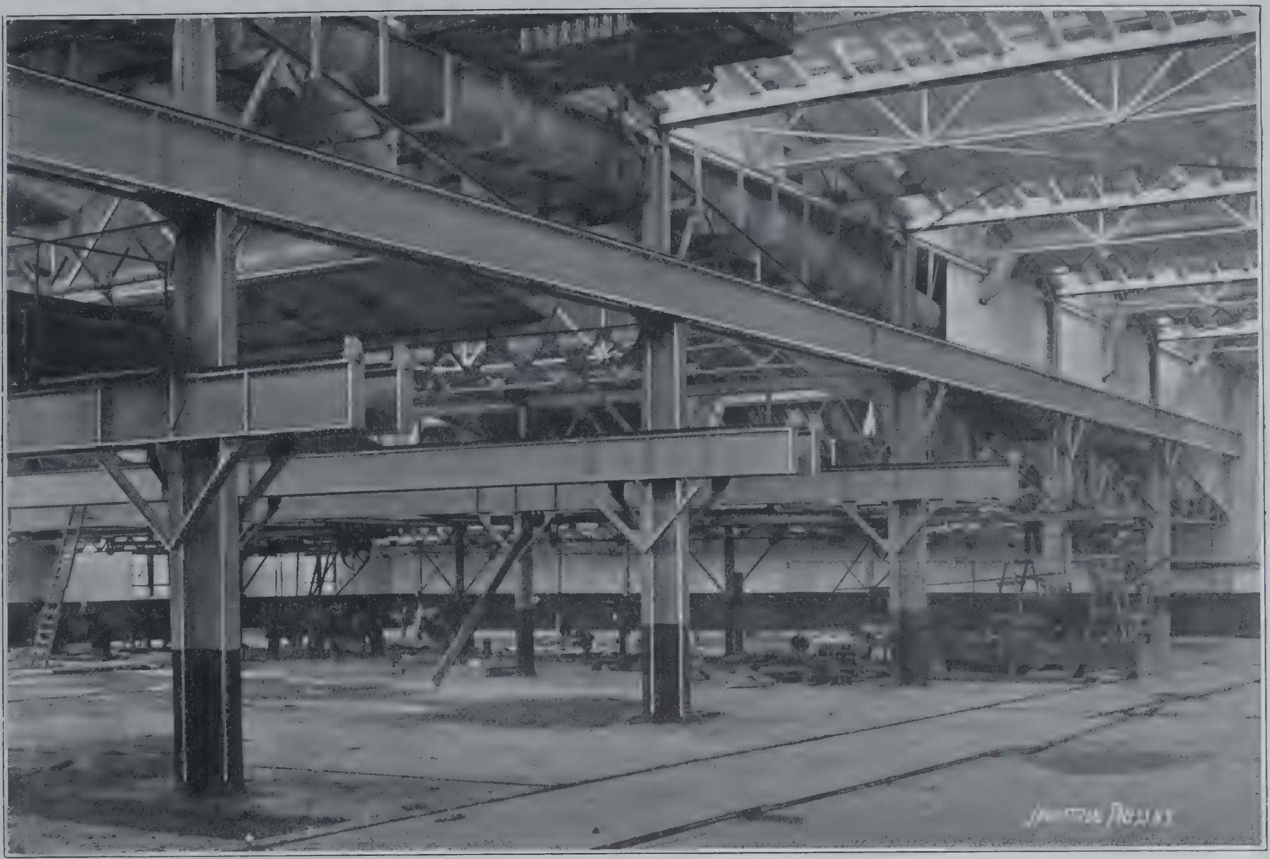


Fig. 3. View of High and Low Sections of Machine Shop, taken from Erecting Shop—Note the Arrangement of Heating Duct and the Extension of Shop Crane Tracks into the Erecting Shop.

It also enables one small crane to be used temporarily on either three of the two machine shop crane runways, since it quite feasible for the erecting shop crane to pick up the small crane and to transfer it from one track to the parallel track. This expedient probably will be resorted to, until the volume of business warrants the purchase of a second crane for the machine shop section.

The cross-sectional view in Fig. 2 shows the arrangements of the tracks very clearly and also the girder construction, which allows the roof to have wide spans between the columns. The building at the right is the erecting shop shown in cross-section; that at the left, the machine shop shown in longitudinal section. The arrangement of the girders which support the roof will be understood by referring to Fig. 2 and also to

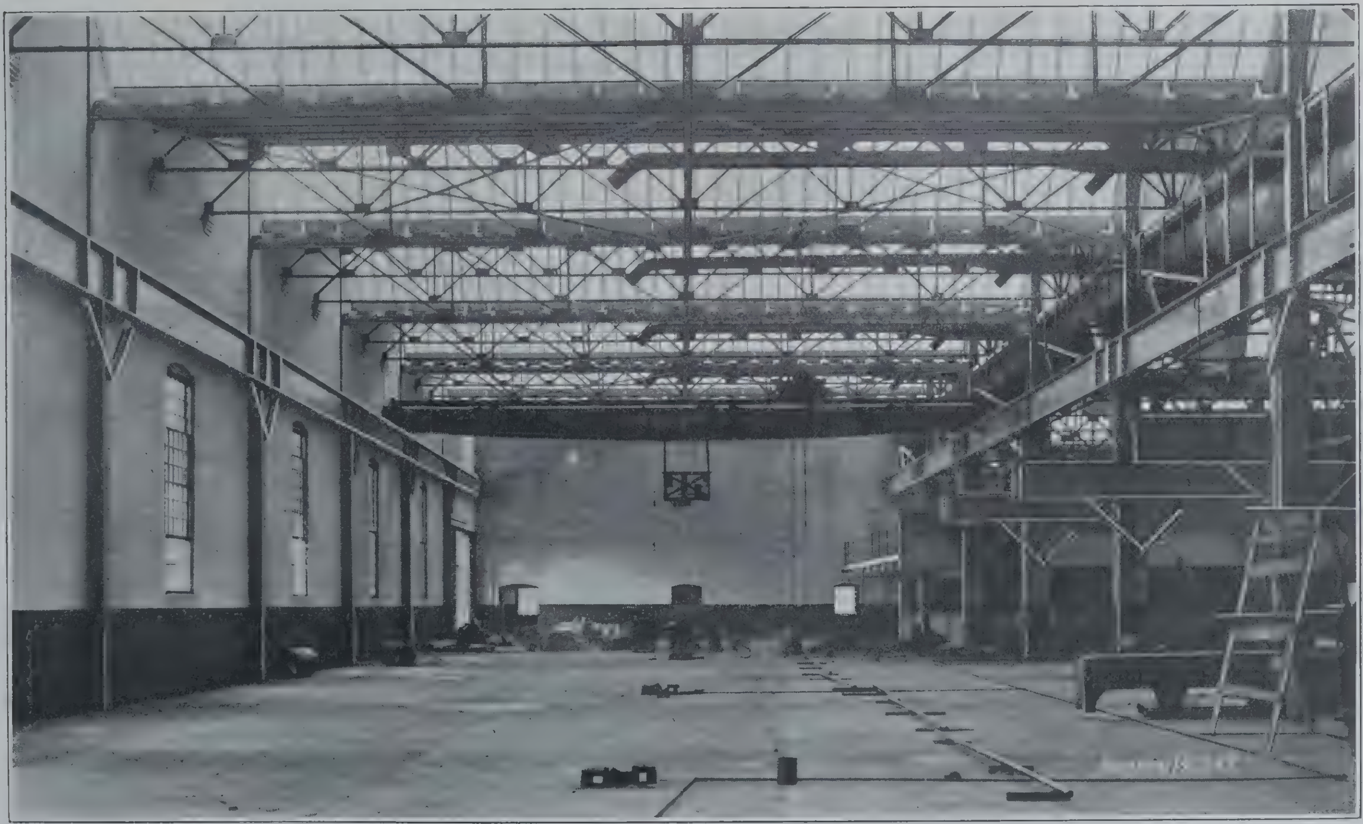


Fig. 4. Erecting Shop with Saw-tooth Roof—Machine Shop at the Right—Car Track enters at the Farther End.

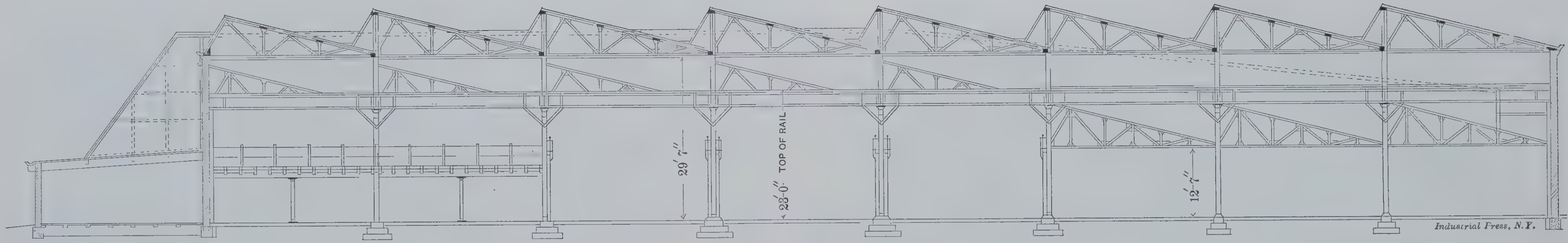


Fig. 5. Longitudinal Section through Erecting Shop.

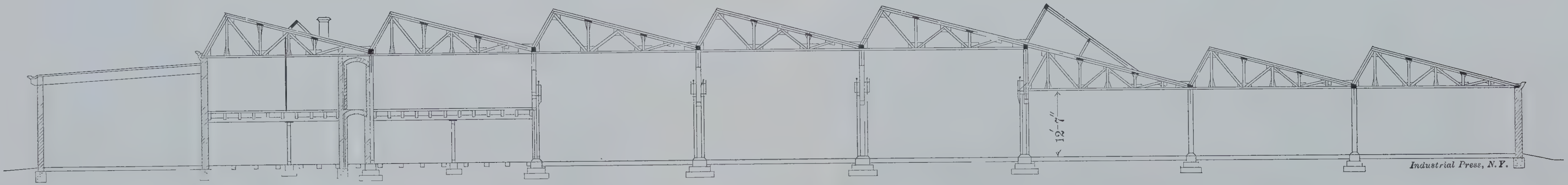


Fig. 6. Cross-section through Machine Shops.

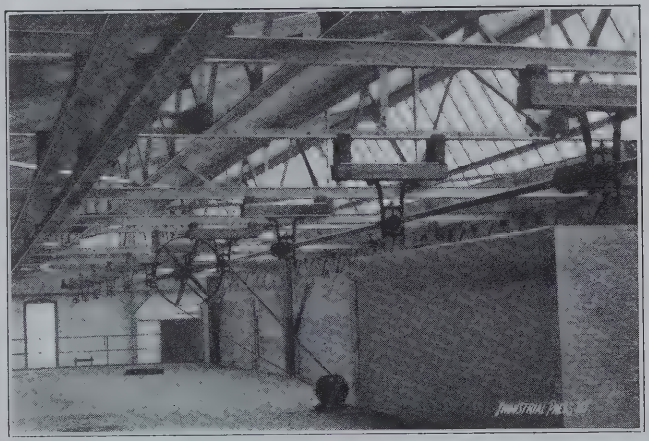


Fig. 7. Method of Supporting Shafting Hangers.

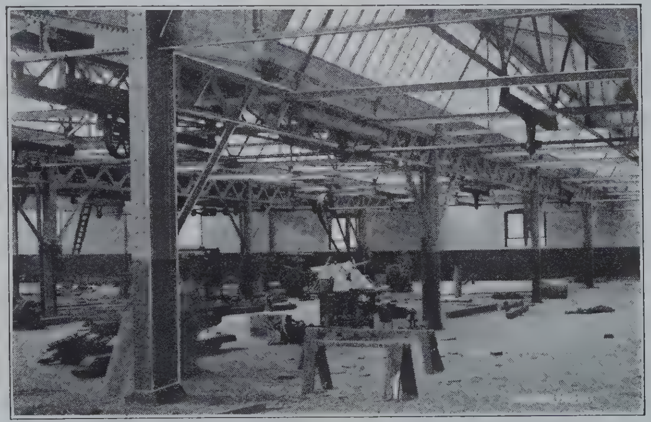


Fig. 8. Low Section of Shop with Overhead Shafting.

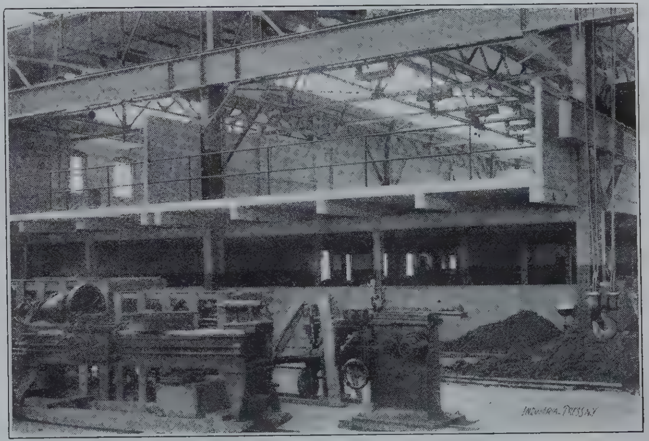


Fig. 9. Section, with Balcony, for Storage, etc.

the half-tone reproductions of the several photographs, which show the interior roof construction.

Fig. 4 is a general view of the erecting shop, which has one of the best-lighted floor areas to be found anywhere. This view shows the relative positions of the traveling crane which serves this department and the crane tracks extended in the form of cantilever beams from the machine departments at the right. Along the west wall and a portion of the east wall of the erecting shop will be arranged a series of jib cranes having a capacity of one ton each. These cranes will give each erector means for handling the small parts without waiting for the main crane.

At the further end of the erecting floor a spur track runs into the shop in a crosswise direction so as to take as little floor room as possible. In this same view, Fig. 4, may be seen, on the upper right-hand side, a duct, previously spoken of, in which the main heating pipe is located.

Further details of the roof construction appear in the two views on this page, where the upper illustration is a longitudinal section through the erecting shop at right angles to the machine shops and looking toward the machine shops. The upper trusses belong to the roof of the erecting shop, and the lower trusses at the left indicate the relative position of the roof for the high section of the machine shop; while the still lower trusses at the right indicate the low section of the machine shop. The heating duct passing up from the engine room appears at the extreme left, and adjacent to it are a gallery and store room. In the lower view on the last page is a section through the various machine shops taken at right angles to the latter and parallel with the erecting shop. These views in connection with Fig. 1 give a clear conception of the roof construction.

Another important feature of the plant is the construction of the machine shop part of the buildings with roofs of two different heights. The low machine shop is adapted for the lighter tools—such as milling machines, drill presses, grinding machines, screw machines, turret lathes, engine lathes and any light tools that do not require crane service. The higher portion of the shop consists of that part served by cranes, where large tools are placed. The erecting shop is necessarily higher than either of the machine shop sections, both for convenience in erecting machinery and in transferring the parts from the machine shop cranes. The buildings are thus of three heights, which makes an economical construction inasmuch as no money was expended for buildings higher than actually required for the work to be done. It also facilitated an economical arrangement of shop driving, as in the low section where no cranes are required the group system of driving can be employed with line shafts. In the high sections of the shop, where there are the larger tools, individual motors are employed, which is desirable for the convenient operation of tools of this class and which also gives clear space for the cranes. Constant-speed motors are used throughout, with a new variable speed device recently brought out by this company. The motors are all to be placed overhead, although in Fig. 7 one is shown located temporarily on the floor. The method of supporting the shaft hangers is indicated in this view. Cast-iron clamps are provided, by means of which stringers are bolted either to the lower member of one of the roof trusses or else to an I-beam suitably located for the purpose. These parts are all made interchangeable and may be shifted about as necessary. Inasmuch as the line shafts will be motor-driven they can be located with reference to the work without the use of angle joints or quarter turn belts. Thus in the automatic screw machine department the shafting is slightly at an angle so that the screw machines may be set to lap by one another, allowing stock to extend through the spindles in the usual manner.

In laying out the shop, arrangements were made to divide it into departments, of which are: First, the planer department; second, the drilling and boring machines; third, the milling and gear-cutting machines; fourth, the engine lathes and grinding machines; fifth, turret lathes and screw machines. The arrangement of the high and low sections of the shop, as previously explained, is such that where these departments run parallel with the erecting shop they may include part of both the high and low sections—an arrangement that would be desirable where there are both large and small tools in one department. The larger tools could then be served by a crane while the smaller tools, not needing a crane, would be placed in the low section of the shop but still be adjoining the larger tools of the same department. In the case of the planer department, where all or nearly all of the machines need the service of a crane, the department runs at right angles to the erecting shop and does not include any of the low section of the machine shop. It will be evident that a great variety of arrangements is thus possible and that, inasmuch as the different parts of the building are adapted to the various tools so far as height is concerned, the initial cost of the buildings must necessarily be a minimum.

The foundations of the plant are of concrete, the walls are brick and the frame work of steel. The roof planking is of 3-inch yellow pine and the skylights of heavy ribbed glass set in metallic sashes. The floor is of concrete. The building covers about 60,000 square feet of floor space, there are 12,000 feet of crane runway, ¾ of a mile of sewers and the expense of construction is distributed as follows:

Steel work per square foot	33.7 cents.
Concrete floor—6-inches	11.5 cents.
Foundations and brick work	10.3 cents.
Lumber	14.0 cents.
Painting	1.1 cents.
Roof covering	1.1 cents.
Sewers	2.0 cents.
Miscellaneous	6.5 cents.
Total cost per square foot	80.2 cents.

This figure is very low and was obtained only by adopting this economical design and using great care in letting the contracts.

* * *

EUROPEAN ENGINEERING WORKS.

The last annual address of the Engineering Association of the South, with headquarters at Nashville, Tenn., was given by W. H. Schuerman, president of the association. He took as his topic a description of some of the important European engineering works visited during a tour of the continent and in what follows will be found an abstract of his paper, attention being given mainly to parts of the paper that bear upon the branches of engineering in which readers of MACHINERY are most interested.

The European freight car is small compared to the American car. The only advantage it can claim is the greater facility with which a single car can be handled by man power, and at nearly all stations a car can be moved from one track to another by means of turntables instead of by switches; but only one car at a time can be handled. The difference in style of passenger coaches is so well known that it is unnecessary to describe it. It may, however, be worth mentioning that the American plan of having entrances at the ends, with a passage through the car and sometimes through the whole train, is coming into use, especially in Switzerland. The passage is, however, nearly always on the side instead of down the center of the car. The fares on ordinary trains in the different European countries are: First-class, 3 1-3 cents per mile; second-class, from 2¼ to 2¾ cents per mile; third-class, from 1¼ to 1 2-3 cents per mile; fourth-class (in Germany, where fourth-class carriages are run), 9-10 of a cent per mile. Nearly all American tourists travel second-class, but third-class in Switzerland and Germany is not objectionable, and traveling third-class in these countries is an excellent way for one, whose funds are limited, to economize.

European locomotives have neither cowcatchers nor bells. To American ears the whistles on Italian locomotives sound like toy affairs. Hand bells are sometimes used in stations to warn people on platforms of the approach of trains; and at one place where some switching was being done the writer saw a man who, to warn people of the approach of the switched car, was running ahead of it and ringing a hand bell about the size of the dinner bell seen and heard at railroad dining rooms and country hotels in the United States.

Switzerland has a large number of incline railways on which adhesion is not sufficient for traction and a rack is made use of instead. These began to come into use shortly after the completion of the Mount Washington railway in the United States in 1869, largely through the efforts of a Swiss inventor by the name of Riggenbach. He had been working on the problem for many years, but some of the professors at the Swiss Polytechnic school had characterized his proposed construction as a monstrosity. John Hitz, the Swiss consul-general to the United States, returned to Switzerland in 1867 and gave a detailed report to the Swiss Federal Parliament of the Mount Washington railway, then being constructed, which greatly encouraged Riggenbach and facilitated the formation of a company. A road up the Rigi was begun shortly after and this was so successful that several others were built by Riggenbach in different parts of Europe.

The next advance after Riggenbach in the construction of rack railways was made by Roman Abt, a pupil and fellow-worker of Riggenbach, the first of whose roads was built in the Hartz mountains. Up to this time the rack rail had always been anchored below the locomotive in which position it would be in compression. Abt conceived the idea of placing it above the wheels, where it would be in tension, and he made his rack rails of flat bars. As now constructed there are two or three racks close together, the teeth of one rack being a third or a half their pitch ahead of the teeth of the adjacent one and there are two or three cogwheels working in the racks. The result is that the locomotive climbs the grade very quietly and smoothly.

Another form of rack railway is that ascending Mount Pilatus. The grades that were found to be necessary were steeper than any hitherto used on rack railways. The average grade is 366 feet per 1,000 feet, the maximum being 480 feet. The maximum grade on the Mount Washington line was 33 feet per 100 feet; that up the Rigi, 25 feet per 100 feet. None of the forms of rack rails in use were considered sufficiently safe for this line, and a new form was devised. Instead of being vertical, the rack is horizontal—or, rather, parallel to the roadbed. The center plate has teeth on both sides, and there are two pairs of cogwheels on the locomotive which gear into the racks. Two trains are operated on this line, which pass each other half way up. Except at the passing point, there is but one track. On account of the form of rack rail and position of cogwheels, the ordinary form of switch could not be used. In place of switches there are two traveling carriages, movable by hand—one above and the other below the passing station. Each carriage carries two connecting tracks, which enables either one of the two tracks at the passing station to be connected to the single track above or below.

The subject of Alpine railway engineering naturally brings to mind the great railway tunnels between Switzerland and Italy. These are more interesting to an engineer during construction than after completion. The Simplon tunnel will be about 11 miles long, and, when completed, will be the longest tunnel in the world. The installation at Brigue consists of the necessary offices, workshops, engine sheds, power houses, smithies, and the numerous buildings required for carrying on such an important engineering undertaking. Great care is taken that the miners and men working in the tunnels shall not suffer by the sudden change from the high temperature of the headings to that of the cool air outside. For this purpose a large building has been erected, in which they can take off their damp working clothes; have a hot and cold bath; put on a warm, dry suit; and obtain refreshments at a moderate cost, before returning to their homes. Instead of each man's having a locker in which to store his clothes, a perfect forest of cords hangs down from the ceiling 25 feet above the floor level, each cord passing over its own pulleys and down the wall to a numbered belaying pin. Each cord supports three hooks and a soap dish, which, when loaded with their owner's property, are hauled up to the ceiling out of the way. There are 2,000 of these cords, spaced 1 foot 6 inches apart, one to each man.

The hydraulic power plants to be found in Switzerland are of as great engineering importance as the rack railways and of much more importance from a commercial standpoint. The city of Geneva constructed a water supply and water power plant in the years 1883 to 1888. The Rhone, at the outlet of the Lake of Geneva, is divided into two branches by an island. The island was extended by a wall, and the left branch of the Rhone thereby made into a canal, closed at its lower end by a large L-shaped power house. In the right branch of the Rhone was built a rolling shutter dam, by means of which the water from the lake, or as much as is desired, can be sent through the left branch to the turbines in the power house. About 4,000 horse power is obtained in this way. There are 20 Jouval reaction turbines of 210 horse power, each operating two pumps. Between 8,000,000 and 13,000,000 gallons of lake water are delivered per day for industrial and public purposes, in addition to 2,800,000 gallons for domestic supply. In the years 1893 to 1899 a second plant was constructed lower down on the Rhone. Many other interesting examples of power plants, made possible by the mountainous formation of Switzerland could be mentioned, but of greater interest still are some of the hydraulic distribution plants to be found at different points on the continent and in Great Britain. London has by far the largest hydraulic power supply plant in the world. There are over 130 miles of hydraulic mains laid in London at present. Powerful pumping engines at seven different stations keep them charged at a pressure of from 700 to 750 pounds per square inch. Another pumping station is now nearing completion. The reservoir of power consists of capacious accumulators loaded to a pressure of 750 pounds per square inch, thus producing the same pressure as a standpipe 1,700 feet high. The power is available, day and night and on Sundays, all the year round at a pressure of 700 pounds per square inch—a pressure which enables small machines to perform a large amount of work with a very small quantity of water. The number of consumers is constantly increasing. The number of gallons pumped per week increased from 1,271,000 in 1886 to 14,812,000 in 1902; the number of machines increased from 364 in 1886 to 4,677 in 1902.

In every town where hydraulic power has been established it has succeeded, both mechanically and financially, notwithstanding the competition of all other forms of power generation and distribution. The experience in Manchester is particularly striking. The supply of electricity, of hydraulic power, and of gas are all in the hands of the corporation. The two former were started at the same time, in 1894.

Other hydraulic works of interest are the numerous locks and dams on ship canals, especially in France and Germany; but all that the writer had time to visit was the ship elevator on the Dortmund-Ems Canal near Henrichenburg. It raises vessels of 600 tons in 12½ minutes through a height of 52½ feet at a single operation. The elevator consists of a tank supported on five huge hollow cylinders, floating in deep wells, 30 feet in diameter, 46 feet from center to center, and going to a depth of 97 feet below ground level. The cylinders balance the whole weight of the tank and its contents. Massive screws regulate the motion, and these screws are constructed to sustain the entire weight of the structure in case of failure in any part. The elevator was selected in preference to the construction of a series of four costly locks, the transit through which would have occupied at least 2 hours in place of 12½ minutes. The massive regulating screw sockets are anchored to solid, square iron plates sunk 30 feet in pits tapering toward the surface and filled in with concrete. Each screw is subject to a maximum stress of 1,476 tons. The tank is 230 feet long, 30 feet wide, and 8 feet deep. It is made of sheet iron from ⅜ to ½-inch in thickness on the sides and ½-inch thick on the bottom. It rests on I-beams, which in their turn are supported on hollow shafts bolted to the center of the floating cylinders and giving access to their interior. The cylinders are 27 feet in diameter and 43 feet high, with a displacement of 811 cubic yards, equal to 3,050 tons. A special feature is the water-tight connection between the tank and the canal. The regulating screws were forged in one piece of Siemens-Martin steel and bored down the center to test the uniformity of the metal. They are, approximately, 71 feet long, 11 inches in diameter, and work in massive collar bearings attached to the supports of the tank and also fixed in the overhead platform connecting the towers. Two coupled shafts, driven by a 150-horse power electric motor, actuate the beveled wheels which turn the screws. In 30 days of from 8 to 10 working hours, 600 ships were passed through the elevator.

* * *

The use of electric motors for hoisting purposes in deep mines has reached a stage of development in Germany that warrants serious attention. The advantages of such practice are not obvious at first inspection as it is the universal custom to place the steam plant of hoisting plants in close relation to the hoisting engine, but the development of power from blast furnace gas and coking plants may often in the future make it desirable to transmit power electrically through considerable distances to the pit mouth. Siemens & Halske, Allegemeine Electricitats Gesellschaft and other German electrical firms have built large motors for hoisting purposes of both the direct-current and of the alternating-current type. The makers are prepared to guarantee a steam consumption of 33 pounds per horse power of useful work when electrically developed, which is said to be considerably less than the consumption obtained of the average steam hoisting engine. This presumably is attained by the greater steadiness of load on the engines, especially where storage batteries are used in conjunction for starting purposes, and by the use of a more economical type of engine, running steadily in one direction.

HEAVY GERMAN MILLING MACHINE.

In a recent issue of *Engineering* (London), is illustrated an extremely heavy and powerful milling machine recently built by the Deutsche Niles Werkzeugmaschinen-Fabrik near Berlin for the Stettiner Maschinenbau Actien-Gesellschaft Vulcan, Bredow, Stettin which firm is using it principally on the connecting and parallel rods of locomotives. The principal dimensions of general interest, are as follows:

Width between uprights	33½ inches
Length which can be milled	11 feet 6 inches
Maximum height between top of table and center of spindle	14 inches
Maximum number of revolutions of cutter arbor	35
Minimum number of revolutions of cutter arbor	14.5
Number of speeds	12
Maximum feed per revolution of arbor	½ inch
Minimum feed per revolution of arbor	1-32 inch
Horse power required, about	50
Net weight about	12 tons

This design of machine, however, is made to other dimensions with regard to width, length, or height. The machine illustrated was guaranteed to mill 4 inches per minute in steel forgings over a width of 20 inches and at a depth of ¼-inch. This guarantee was fulfilled, the test result showing a milling feed of 9¾ inches per minute in steel having a width of 16½ inches, while removing 3-16-inch of the stock. One test is cited where the tool was driven by a 50-horse power motor, taking a cut of .20 inch at a speed of 4.17 inches, from a coupling rod 23.62 inches (600 millimeters) wide. These are certainly most satisfactory results. The cutter in use on this occasion is illustrated separately in Fig. 3, herewith, as this form is preferred to that adopted for the cutter shown in the machine as illustrated. The table runs in V ways, the surfaces of which are inclined one toward another, as shown in Fig. 1. The table has longitudinal power feed at ten different rates; quick adjustment in either direction is provided, with automatic stop. The thrust of the leading screw is taken up by ball-bearing. A counterweight guards the table from any vibration. The machine is driven by cone and two worm gears, giving very smooth running. The second worm gear is not placed direct on the spindle, but separately; the spindle is driven by a special dog to prevent lost motion. Special provision is made for taking up all wear of the cutter arbor. An outer and middle bearing support the arbor, which has horizontal adjustment. The crossrail adjusts vertically by hand.

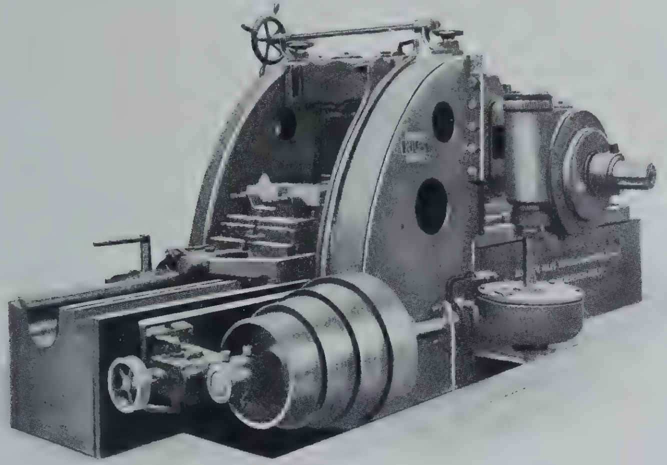


Fig. 1. German Milling Machine weighing twelve tons and requiring fifty H. P. for Driving.

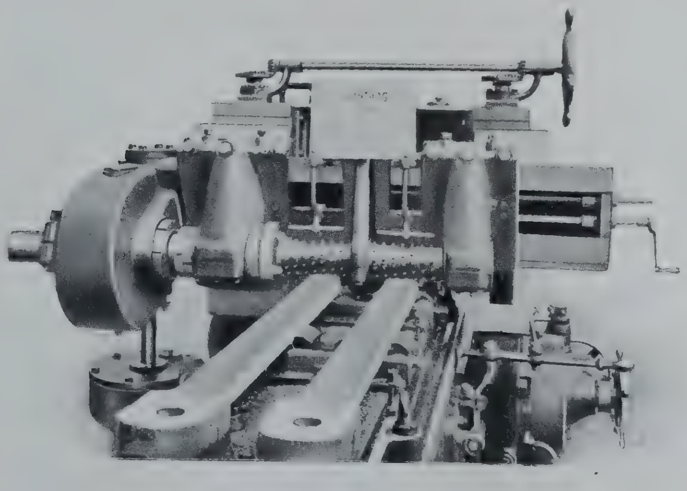


Fig. 2. Examples of Heavy Milling.

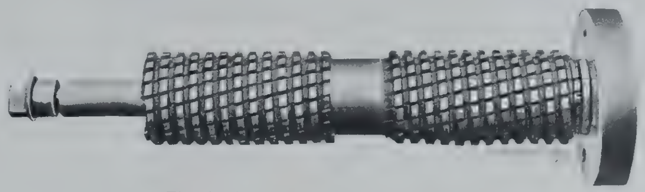


Fig. 3. Type of Spiral Cutter used.

* * *

NOTES FROM THE SHOPS OF THE CHAMBERSBURG ENGINEERING CO.

The class of work now done by the Chambersburg Engineering Co. is mostly steam hammers, hydraulic riveters, flanging presses, accumulators and other hydraulic machinery of allied nature. A large part of this work is very heavy. The two steel castings for the frame and stake of the 204-inch gap riveter built by this concern weigh about 110,000 pounds. As the overhead works for handling heavy castings are not of the best modern type, the work is not shifted about more than can be reasonably avoided. The practice is to do as much on one machine as possible for that machine before it goes to the next one and so on. In the case of steam hammers the frames must be planed across the top for the steam cylinder and parallel to the frame for the guides. Both jobs of planing are done on the planer to which the job is sent first. Two planers, one of the ordinary type and the other a Detrick & Harvey open-side machine, are used for this work. In the case of the ordinary planer the end of the frame for the steam cylinder is planed with the frame blocked up on the floor, the planer platen carrying the tool and acting as a shaper. A small planer housing is bolted to the platen in a vertical position which carries a tool slide by which lateral adjustment and vertical feed can be secured. The planing of the guides is, of course, an ordinary planer job. The Detrick & Harvey machine handles such jobs in the characteristic manner. The point is that neither planer relinquishes the job until it is completed so far as planing operations go.

Deep pits are provided for erecting steam hammers and hydraulic riveters. The frame of the machine sets down in the pit at such a depth that ordinarily the top where the cylinder and other mechanism is being placed, comes about even with the shop floor. Planks laid across the pit make this work as convenient as could be desired, but if it was done with the frame in the air, it would mean the erection of a staging and much climbing up and down. The largest riveters (204 inches gap) cannot be done in this manner as the pits are not deep enough so they are laid down on the erecting shop floor.

Steel packing rings made from cold-rolled steel are used to a certain extent in the steam hammers. These are rolled up from stock of the exact size required, using a machine which has three rolls. Two of the rolls are provided with five grooves of varying widths and depths to receive the stock and constrain it to roll into one plane. The other roll is left smooth. The smooth roll and one grooved roll are geared together; the third roll acts as an idler and is provided with screw adjusting boxes to vary the curvature of the ring being rolled. Steel packing rings are used in steam hammers on account, of course, of the breakage incident to those made of common cast-iron.

* * *

The Canadian Pacific Ry. has ordered 20 locomotives from Germany in order to secure prompt delivery. This is said to be the first instance of an American road purchasing locomotives in Germany.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JUNE, 1903.

NET CIRCULATION FOR MAY, 1903,—27,229 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

In setting up so simple a machine as a blacksmith's tilt hammer, there are at least two conditions affecting the drive that must be properly met to get satisfactory action: First, the belt should run in the direction that brings the tightener pulley on the slack side of the belt; otherwise the smith must bring an abnormally heavy pressure on the treadle when using the hammer. With the tightener on the slack side of the belt, a slight pressure usually suffices to drive the hammer at top speed. Although this may seem obvious to most mechanics, it apparently is not to some. We remember a tilt hammer that ran for years with the tightener on the tight side of the belt. The consequence was that a helper had to accompany the smith to the hammer each time it was used. The second condition referred to is that the center distance between the countershaft pulley and the crankshaft pulley does not exceed a certain distance, say 7 or 8 feet. If it is greater than this distance, say 12 feet or more, trouble will likely be experienced in getting and keeping the driving belt the right length. If it is slack enough to allow running freely over the lower pulley when not in use, the tightener pulley will have to move through too great a distance to start the machine to work. To overcome this trouble the belt will probably be cut so short that it rubs and frets against the lower pulley and soon wears itself out.

* * *

CHANGE GEAR DEVICES AND GEARED FEEDS.

We begin this month a series of articles upon change gear devices for engine lathes by the author of the recent series upon shop construction. In common with others directly interested in lathe construction, Mr. Perrigo has spent a great deal of time investigating "the state of the art" with respect to such devices; but he has also gone one step further and prepared a manuscript for publication upon the results of his researches. While the articles deal solely with devices designed for screw cutting, they embody the principles of similar mechanisms that are to be found on various machine tools for feeding the tool in the ordinary process of machining. It is hardly necessary to say that the series is timely and that it will add another to the important articles upon machine construction, which have been characteristic of the columns of MACHINERY.

Nests of gears for machine feeds have been in limited use for many years on an occasional drill press or engine lathe and have been employed regularly on the Bullard boring mill and Becker miller from the first; but it was not until W. P. Norton became associated with the Hendey Machine Co., Torrington, Conn., and the latter firm took up the Norton change-gear device that a geared feed became popular. One of the first to build a lathe with a change gear mechanism having a nest of gears was Prof. John E. Sweet, and he has written us as follows upon the subject:

"The first application in practical form of fixed change gears that I know of was by Ferris and Miles, who exhibited a lathe at the Centennial with a projecting spindle outside the bed, carrying eight gears, if I remember correctly, into which a tumbler gear, swinging on the screw and engaging a gear on the screw, communicated the motion.

"The mechanism was in principle very like the Hendey-Norton, with this marked difference—that Ferris and Miles' was outside the bed, whereas the Hendey-Norton mechanism is inside.

"The next, so far as I know, was the one I designed while at Cornell in 1878, and which was built in the University of Wisconsin in 1881 or 1882 and illustrated in the *American Machinist* in 1889, or thereabouts.

"This I believe to have been the first lathe with the change gears inside the bed, but really Hendey and Norton are entitled to the credit for what has been done, because they are the ones who built up such a business out of it that others have been forced to follow.

"It is not so much who did the thing first as who made the thing go."

* * *

IS IT A FAD?

The changes in machine tools during the past ten years have all been in the direction of getting more work out of the machine in a given time. This has come about through the introduction of automatic features in some instances, but more generally through increase in weight and stiffness, more powerful drives, more speed changes and the use of nests of gears by which not only is a stronger and more positive feed obtained, but, what is more to the point, a feed exactly adapted to the tool and the work. Lathe manufacturers are quite generally adopting or considering the adoption of some quick-change gear device for screw cutting, and in some instances for the regular feeds as well, while makers of milling and drilling machines are following in their footsteps with similar feed arrangements.

The question naturally arises, Is this drift toward quick-change devices for screw-cutting and turning anything more than a fad? Many contend that a lathe with such mechanism is too expensive, and liable to give less accurate results; that a milling machine is, after all, better with a belt drive; that screw-cutting is done so seldom that it is no burden to change the gears by the old method, and so on to the end. There is some truth in these claims, and it is a fair question whether, after all, a good, strong belt-driven feed, and the old system of separate change gears are not as satisfactory as any, for the majority of work.

The fact remains, however, that the most expensive luxury around a machine shop of the present day is considered to be the factor of time. Expensive machines are considered a better investment than cheaper ones, provided they will *save time*. A machine, therefore, which will give a mechanic just the speeds he wants and just the feeds he wants, whether in screw-cutting, turning or what not, and give them quickly, is bound to be a time saver and so is deservedly popular. It is this which has made the multiple voltage system of independent driving so well liked and if one is going to the expense of installing so elaborate an arrangement as this to secure convenient speed manipulation of machine tools, he ought by rights to have the machines equipped with equally as good a feed mechanism to go with it. Geared feeds have got beyond the fad period. While it is easy to see that there are many places where it would not pay to so equip a machine, any more than it would with a multiple voltage drive, we believe that fixed-gear mechanisms, both for feeds and screw-cutting, will be thought more and more essential in order to get the greatest possible amount of work out of the machine.

HIGH-SPEED PLANER WORK.

We have received a communication from the foreman of a large machine shop, doing much heavy planing, inquiring what is being done in the matter of fast-cutting speeds on planer work with the new high-speed steels. Considerable data and other information have been published regarding fast-cutting speeds on lathes, but little has been said about increased planer speeds. The principal planer manufacturers having been solicited for information on the matter, with one or two exceptions, have expressed the opinion that from 25 to 30 feet per minute is about the limit of cutting speed that should be attempted with the larger planers built by them, regardless of the speed the steel will stand. Higher speeds than these are believed by most of the planer builders to cause so much lost time and expense for repairs and grinding tools that there is little, if any, gain in the end. They are not, however, unanimous in this opinion, as will be seen from the following extracts which are substantially as expressed in the letters received:

William Sellers & Co. say they have built planers up to 10′ × 10′ square between the housings with variable cutting speeds from 3 to 48 feet per minute and with a constant return speed of 96 feet per minute, which are in very successful operation. They have recently applied the variable speed feature to one of their 10′ × 10′ × 36′ shop planers.

The G. A. Gray Co. do not believe that planers larger than 30″ × 30″ can be run faster than 30 feet successfully as a general thing, although they have built one 30″ × 30″ for a customer who claims to be running it at the rate of 66 feet cutting speed. They have found in their own shop experience that large surfaces like planer platens can be most economically handled at from 20 to 25 feet per minute and they do not recommend running faster than the latter speed.

The Woodward & Powell Planer Co. say that they have run their planers at a speed of 40 feet per minute, cutting a fine quality of cast-iron. The cutting tool was made of the best steel they could obtain and the chip was light. They are of the opinion that this speed is too high for most practical purposes and recommend a cutting speed of 20 to 30 feet per minute with a return speed of about 50 to 60 feet per minute.

The Niles Tool Works branch of the Niles-Bement-Pond Co., say they are conversant with cases where a cutting speed of from 25 to 30 feet is employed successfully, and believe from their own experience and that of others using heavy planers, that 30 feet per minute is perhaps as economical as any higher speed that might be obtained.

The Whitcomb Manufacturing Co. have a 26″ × 26″ × 12′ second-belt-drive planer running at a cutting speed of 45 feet, which is working successfully on very difficult work, being planer crosshead work, and digging out and finishing angular and square gibs. Another planer of the same type in their shops is running at a speed of 36 feet per minute. They believe that for planers 36″ × 36″ and larger, 30 feet per minute is about the limit where only one cutting speed is available, but if two cutting speeds are available they believe that much higher speeds than 30 feet can be used much of the time on ordinary work.

In regard to the value of more than one cutting speed, the Betts Machine Co. say that there are many instances where higher cutting speeds could be used than would otherwise be practical. For one uniform cutting speed on heavy planers, they recommend 25 feet per minute.

The Cincinnati Planer Co. have one of their 48″ × 48″ planers running at a cutting speed of 35 feet per minute at the Schenectady plant of the American Locomotive Co., which is doing good work and giving very good satisfaction at that speed. In their own shops this firm have a 24″ × 24″ planer running at a constant cutting speed of 38 feet per minute. One of their 36″ × 36″ planers is run at a cutting speed of 42 feet per minute on light roughing cuts, but is slowed down for finishing, a variable speed countershaft being provided for this purpose. Their other planers including the large ones are run at 26 to 30 feet per minute. Their experience is that the majority of shops are not able to run at cutting speeds much higher than 24 to 25 feet per minute. One of their planers 48″ × 48″ × 18′ is running at the Elliott Frog & Switch Works at a speed of 24 feet per minute, working on steel rails, but so far the only tool steel found to stand up to this severe work is Novo.

Another firm, that did not wish to be quoted, wrote conservatively regarding the higher cutting speeds, believing that the most efficient results are obtained with speeds of 15 to 20 feet per minute. This firm, however, has recently built two planers for a railroad shop to plane 26 feet long with a cutting speed of 30 feet per minute.

The Bement, Miles & Co., branch of the Niles-Bement-Pond Co., have an extremely heavy 72-inch frame planer used in the Juniata shops of the Pennsylvania Railroad working successfully at a cutting speed of 40 feet per minute, but it was not built for such high speed. Another planer in these shops is planing cylinders at about the same cutting speed.

* * *

NOTES AND COMMENT.

Some of the expedients resorted to in the manufacture of very fine wire are most ingenious and interesting. It is generally known that platinum wire can be drawn to exceedingly small diameters, even as slight as 1-50,000 inch, but how it is done is another matter. We understand that one method is to reduce the wire to as small a diameter as possible by ordinary drawing methods and then to coat it with a heavy layer of silver. The compound wire is then drawn down until the interior platinum wire is reduced to the desired diameter, and then the silver is dissolved off, leaving the platinum wire intact.

In a letter to *Engineering* (London) on the stresses set up in a crank web when shrunk on its shaft, Mr. Albert Kingsbury, Worcester, Mass., concludes that a shrinkage allowance of 1-1000 the diameter (0.001 inch to 1 inch) is about as much as can be safely made if the stresses are kept within the elastic limit for wrought iron and steel. To this should be added a slight allowance for roughness of the shaft, say 0.001 to 0.002 for shafts of fairly large diameters. He intimates that shrinkage allowances of 1-350 to 1-500 the diameter are quite certain to cause the elastic limit to be exceeded. For cast-iron webs the shrinkage allowance should be even less than with iron or steel to avoid exceeding the elastic limit.

The development of the electric street railway has created a class of mechanical officials who are neither "fish nor fowl" so far as the existing railway and electrical organizations go. The master mechanic of a street railway line, while he may be a practical electrician all right, scarcely feels at home at a meeting of the electrical engineers, and he certainly feels equally isolated at the railway master mechanic's conventions. A society for this body of men, called the American Railway Mechanical and Electrical Association, was organized in Cleveland, Ohio, last February, and will hold its first annual convention at Saratoga, N. Y., September 1-4, in conjunction with the meeting of the American Street Railway Association. A number of interesting and profitable papers are promised.

In the February issue mention was made of a new and valuable use that has been discovered for carborundum, and that was as a lining for covering the firebrick of furnaces with a highly refractory coating. It appears from recent discoveries made at Niagara Falls by Mr. Acheson that "siloxicon," which is a somewhat different product from carborunrum, is more likely to be largely used for this purpose since it is a self-binding material, having only to be mixed with water to be applied. Siloxicon forms in the electric furnace at a temperature of from 4,500 to 5,000 degrees, whereas carborundum is said to require about 7,000 degrees F. Siloxicon can be used alone as a refractory covering for furnace interiors, but for some purposes it is better to use a binding agent such as liquid tar, asphaltum, pitch, molasses, glue or other materials of a hydrocarbon or carbonaceous nature. The prospective field for the use of this refractory lining is large, as it will be valuable for muffles, crucibles, furnaces, tuyeres and other apparatus in which firebrick is exposed to very high temperatures.

CONSTANTS FOR VARIABLE SPEED DEVICES.

JOHN S. MYERS.

One of the live problems at the present time among machine tool designers is the perfection of a variable speed device capable of transmitting the horse power required for driving the modern machine tools.

The advent of the new tools permitting much higher cutting speeds and the now increasing tendency of manufacturers toward as little hand scraping as possible but instead, inserting broad flat tools, and running very slow, performing the scraping operation in the machine, have made a wide range of speed imperative. This has necessitated greater backgear ratio, more ratic at the cone and usually more and finer steps. It is here that the variable speed device usually has its origin. Most of these operate upon the principle of expanding disks or cones, which is a variation of the cone pulley problem. There are, however, quite a number of variable quantities involved in a simple pair of cones that sometimes prove troublesome.

The following formulas and table of constants were developed for use in determining the quantities pertinent to the designer in a speed-varying device operating on the principle of expanding disks or pulleys, a pair of such disks being belted together. It is quite evident that the formulas are equally applicable to the ordinary stepped cones in more general use or to a nest of gears on parallel shafts. The writer hopes the appended table may be useful in this connection:

Let D = Maximum cone diameter in inches.
D_1 = Minimum cone diameter in inches.
D_2 = Even cone diameter in inches.
D_3 = Variable shaft cone diameter for mean speed.
D_4 = Constant shaft cone diameter for mean speed.
R = Ratio of maximum to minimum speeds.
S = Speed of constant and of variable shaft at even cone diameters.
S_1 = Maximum speed of variable shaft.
S_2 = Minimum speed of variable shaft.
S_3 = Mean speed of variable shaft.
V = Maximum belt velocity feet per minute.
V_1 = Minimum belt velocity feet per minute.
V_2 = Mean belt velocity feet per minute.
V_3 = Velocity at mean number of R. P. M.

Then

$$D = D_1 \sqrt{R}$$

$$D_1 = D\left(\frac{1}{\sqrt{R}}\right)$$

$$D_2 = \frac{D + D_1}{2} = D\left(\frac{1 + \frac{1}{\sqrt{R}}}{2}\right)$$

$$D_3 = D_2\left(\frac{4}{\sqrt{R} + \frac{1}{\sqrt{R}} + 2}\right) =$$

$$D_2\, w = D\left(\frac{2 + \frac{2}{\sqrt{R}}}{\sqrt{R} + \frac{1}{\sqrt{R}} + 2}\right) = D\, y$$

$$D_4 = D_2\left[2 - \left(\frac{4}{\sqrt{R} + \frac{1}{\sqrt{R}} + 2}\right)\right] = D_2\, z$$

$$D_4 = D\left[1 + \frac{1}{\sqrt{R}} - \left(\frac{2 + \frac{2}{\sqrt{R}}}{\sqrt{R} + \frac{1}{\sqrt{R}} + 2}\right)\right] = D\, x$$

$$S = \sqrt{S_1 S_2}$$

$$S_1 = S \sqrt{R}$$

$$S_2 = S\left(\frac{1}{\sqrt{R}}\right)$$

$$S_3 = \frac{S_1 + S_2}{2} = S\left(\frac{\sqrt{R} + \frac{1}{\sqrt{R}}}{2}\right) = S\, v$$

$$V = S\,\frac{\pi D}{12}$$

$$V_1 = \frac{V}{\sqrt{R}}$$

$$V_2 = \frac{V + V_1}{2} = V\left(\frac{1 + \frac{1}{\sqrt{R}}}{2}\right)$$

$$V_3 = V\left[1 + \frac{1}{\sqrt{R}} - \left(\frac{2 + \frac{2}{\sqrt{R}}}{\sqrt{R} + \frac{1}{\sqrt{R}} + 2}\right)\right] = V\, x$$

TABLE OF CONSTANTS.

R	$\sqrt{R}$	$\frac{1}{\sqrt{R}}$	$\frac{1+\frac{1}{\sqrt{R}}}{2}$	v	w	y	x	z
1.5	1.224	.817	.909	1.021	.990	.924	.893	1.010
2.	1.414	.707	.854	1 061	.971	.828	.879	1.029
2 5	1.581	.633	.817	1.107	.944	.775	.858	1.056
3.	1.732	.577	.789	1.154	.928	.732	.845	1.072
3.5	1.871	.534	.767	1 203	.908	.696	.838	1.092
4.	2.000	.500	.750	1.250	.889	.667	.833	1.111
4.5	2.121	.472	.736	1.296	.871	.641	.831	1.129
5.	2.236	.447	.724	1.342	.854	.618	829	1.146
5.5	2.345	.426	.713	1 386	.839	.598	.828	1 161
6.	2 450	408	.704	1.429	.823	.580	.828	1.175
6.5	2.550	.392	.696	1.471	.809	.563	.829	1.191
7.	2 646	.378	.689	1.512	.796	.549	.829	1.204
7.5	2.739	.365	.683	1.552	.784	535	.830	1.216
8.	2.828	.353	.677	1.592	.772	.522	.831	1.228
8.5	2.915	.343	.672	1.629	.761	.511	.832	1.239
9.	3.000	.333	.667	1.667	.750	.500	.833	1.250
9.5	3.028	.330	.665	1 679	.747	.497	.834	1.253
10.	3.162	.316	.658	1.738	.731	.481	.836	1.269

* * *

CALCULATION OF MOMENT OF INERTIA OF A PLANE FIGURE.

SANFORD A. MOSS.

The calculation of the moment of inertia of a complicated figure is a laborious operation, and unless great care is taken mistakes are likely to be made. The following systematic method of carrying out the various computations will be found to reduce the labor and to give certainty of a correct result.

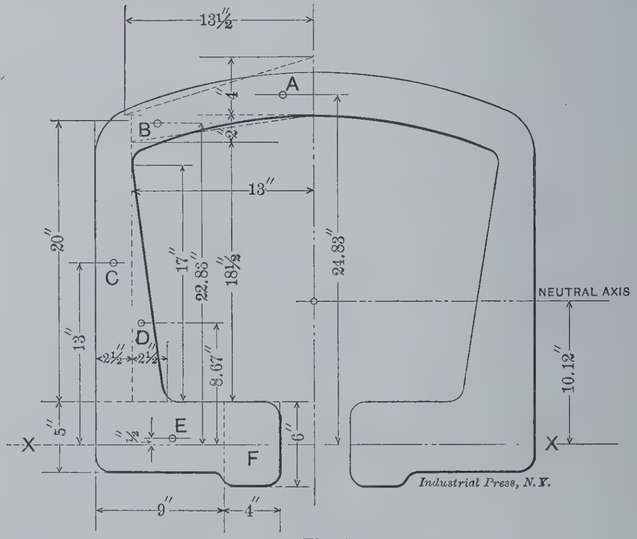


Fig. 1.

Let Fig. 1 be a figure whose moment of inertia is to be found. A dimensioned sketch of the figure must be made. A free-hand sketch will do if made approximately to scale. Divide the figure up into rectangles and triangles, as indicated by the dotted lines, approximating the figure as closely as the desired accuracy requires. From the given dimensions find the breadth and height of each of the various rectangles and triangles. The "breadth" is the dimension parallel to the direction of the neutral axis; and the "height" the dimension perpendicular to it. Of course the direction of the neutral axis must always be known in the beginning.

Select a line parallel to the known direction of the neutral axis, as a reference axis. This we shall call the "X axis." It may be at any convenient point on the figure. However, the work is slightly simplified if the X axis is drawn through the center of gravity of the lowest one of the rectangles or triangles. Find the distance from the X axis to the centers of gravity of the rectangles and triangles.

The center of gravity of a rectangle is, of course, at half its height. The triangles should all be selected so that the base is parallel to the neutral axis. Then the center of gravity will be at a distance from the base equal to 1-3 of the height.

Set down the various breadths, heights and distances from the X axis to the centers of gravity as dimensions of the figure. These dimensions can usually be found by mental computation. If the figure is drawn accurately to scale the dimensions may be checked by being gone over with a scale afterward.

Letter the rectangles and triangles A, B, C, etc., beginning with the one whose center of gravity is farthest from the X axis and proceeding successively according as the distances of the centers of gravity from the X axis diminish. If the figure is symmetrical, or if for any other reason there are several rectangles or triangles of the same height, and whose centers of gravity are at the same distance from the X axis, they are all to be counted together as a single rectangle or triangle whose breadth is the sum of the several breadths.

FIG. 2. FORM FOR CALCULATION OF MOMENT OF INERTIA OF A PLANE FIGURE.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Part.	R or T	Breadth.	Height.		$\frac{bh}{2}$ if T bh if R	Distance from X axis.		x − Z		y × a y and $\frac{h^3 \times b}{36}$ if T $\frac{h^3 \times b}{12}$ if R		y^2 and $\frac{h^2}{18}$ if T $\frac{h^2}{12}$ if R		
		b	h	h^3	a	x	a x	y	a y		h^2	y^2 and e	$y^2 + e$	$a \times (y^2 + e)$
A	T	27	4	64	54.	24.83	1340.8	14.71	794 3	11685 48	16	216.38 .89	217.27	11732
B	T	26	2	8	26.	22.83	593.5	12.71	330.4	4200 6	4	161.54 .22	161.76	4206
C	R	5	20	8000	100.	13.	1300.0	2.88	288.0	830 3333	400	8.29 33.33	41.62	4162
D	T	5	17	4913	42.5	8.67	368.4	−1.45	1412.7 −61.6	89 682	289	2.10 16.06	18.16	772
E	R	18	5	125	90.	.5	45 0	−9.62	−865.8	8329 187	25	92 54 2.08	94.62	8518
F	R	8	6	216	48.	0.	00.0	−10.12	−485.7	4916 144	36	102.41 3.00	105.41	5060
					360.5		3647.7		−1413.1	34449				34450

$360.5 = \text{Area} \quad \frac{3648}{360.5} = Z = 10.12$ $\quad$ 34449 = Moment of Inertia. $\quad$ 34450 = Moment of Inertia (check)

Rule off a table as shown by Fig. 2, of course leaving the space for the various numbers blank for the present. In column 1 place the designating letters of the various rectangles or triangles. In column 2 place the letter *R* or *T* according as the figure is a rectangle or a triangle. In column 3 place the breadth. This is to be the sum of all of the breadths, if there are several rectangles or triangles which have the same height and which are at the same distance from the X axis, as already stated. In column 4 place the height, and in column 5 the cube of the height. This is most conveniently found from a table of cubes. The squares of the height for column 12 may be filled in at the same time.

In column 6 place the products of the numbers in columns 3 and 4, dividing by 2 for triangles. This evidently gives the areas of the various figures. In this, as in all of the numerical calculation, care must be taken. The lower scale of a 10-inch slide rule will give sufficiently close results *if care is taken to estimate the last figure.*

It is now becoming customary to make all engineering calculations on some one of the more accurate calculating instruments, such as Thatcher's or Fuller's slide rules. The sample calculation given was made on a slide rule with a scale 250 inches long.

In column 7 put down the distances of the various centers of gravity from the X axis. In column 8 put down the products of the figures of columns 6 and 7. Find the totals of columns 6 and 8 and divide the total of column 8 by the total of column 6. The result will be the distance of the neutral axis from the X axis, which we will call Z. Subtract Z from each of the numbers of column 7 and put down the result in column 9. Negative results must of course be indicated with a minus sign.

In column 10 put down the products of the numbers in columns 6 and 9, giving the negative sign when it occurs. Add together all of the positive terms in column 10 and then all of the negative terms. The results will be equal if the work up to this point has been done correctly. In column 11 put down the products of columns 9 and 10, and also the products of columns 3 and 5, dividing the latter by 36 for triangles and 12 for rectangles. Add column 11 and the result will be the desired moment of inertia.

In order to be sure that all of the numerical work has been done correctly, the moment of inertia may be found in another way for a check. This is done with 12, 13, 14 and 15. Of course if no check is desired these columns need not be filled out.

In column 12 put the squares of the numbers of column 4. In column 13 put the squares of the numbers in column 9, and also the results obtained by dividing column 12 by the number 18 for triangles or the number 12 for rectangles, calling these quotients "*e*." In column 14 add the two numbers for each line of column 13. In column 15 put down the products of columns 14 and 6. The sum of this column will be the moment of inertia and it should agree with the previous value. If it does not, there is a mistake in some of the numerical work. The sum of the two numbers for each line in column 11, should be the same as the number of column 15. This fact will assist in the location of a mistake. If the positive and negative parts of column 10 are equal and if columns 11 and 15 give the same sum, the value thus found for the moment of inertia is almost absolutely certain to be correct.

* * *

The amount of flow over Niagara Falls has been estimated to be 275,000 cubic feet per second or 500 tons per minute. As the total fall available from the beginning of the upper rapids to the foot of the cataract is 216 feet, the theoretical horse power figures to more than 6,000,000, of which about one-sixteenth will be utilized in the near future.

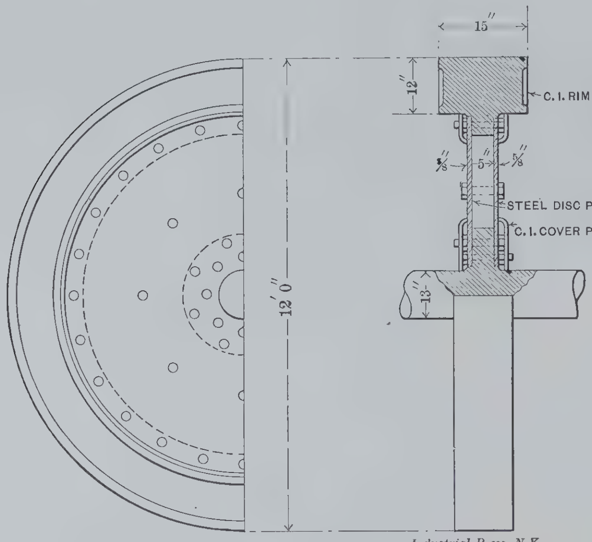
FLYWHEELS,

THEIR PURPOSE, PRINCIPLE AND DESIGN—CALCULATION FOR SPEED VARIATION.

WILLIAM BURLINGHAM.

This article is not supposed to be highly mathematical or to enter into the nice points of flywheel design. It will have served its purpose if it gives the working machinist a fairly good idea of some of the difficulties that are inherent in this work, and the reasons for the adoption of the varying types of wheels.

What is the purpose of a flywheel? In a steam engine or other reciprocating machine, where reciprocating motion is transformed into one of rotation, there must always be a variation in the amount of rotative effort, without regard to how constant the force of reciprocation may be. Therefore a varying and corresponding change of acceleration must take place, either plus or minus, coincident with the change of effort. In addition to this, the work required of the engine is constantly fluctuating and this also varies the effort.



Industrial Press, N.Y.

Fig. 1. Steel Disk Flywheel.

As regards the attachment of flywheels to machines, for the conversion of mechanical into electrical energy, the uniformity of the required speed is still more important and the revolutions of the machine must be kept within a variation of certain limits; or, in other words, the speed must be practically constant. The governor, of course, comes into play to help the flywheel out, the duties of the two being respectively as follows: The flywheel, to control the tendency to change in speed, due to an unequal amount of internal effort in the engine; the governor, to limit the variation from the change in the external load. In addition to this, the flywheel practically automatically compensates or smooths over any quick changes of the external load; if this quick external load continues to change for any appreciable length of time, the governor gradually comes into action.

The principles involved are the following: As work spent is always equal to work accomplished, it follows that, if we neglect friction, the work represented by the "mean pressure on the piston acting over the length of the stroke" must equal the tangential turning effort on the crankpin, acting through half a revolution, the latter product representing the resistance. If equality existed at all points of the stroke between the work spent and the resistance, a flywheel would not be needed; but as it is, when a piston transmits more pressure to the crankpin than is necessary for the resistance to be overcome, the wheel must absorb the surplus, and the velocity of the wheel is accelerated by this surplus and work is stored up in it. If the piston fails to transmit sufficient tangential pressure either from want of actual pressure or because the crank is near or at the dead center, the work stored in the wheel is given out to the shaft again. When the engine reaches its mean speed, which speed may vary from day to day in proportion to the work it is doing, it is only the fluctuations above or below these mean speeds that the flywheel has to look out for.

The influences of the inertia of the reciprocating parts is important in all large engines, where the moving parts have great mass and the velocity is considerable. The effect of inertia may be considered as a force acting in opposition to the steam pressure at the inner dead center, and in conjunction with it at the outer dead center. The flywheel does nothing to make the mean effort of the engine equal to the mean resistance.

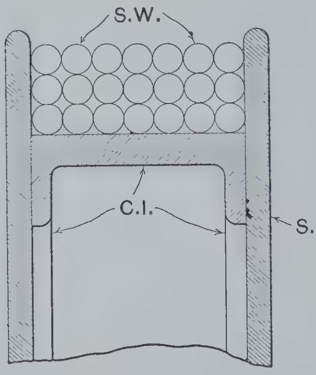
The ordinary flywheel used in this country is built of cast iron, and we have had many serious accidents from the bursting of these wheels, because of bad design, hidden flaws, or wheels that were run way above their designed speed. Wheels will run away now, and will run away until the end of time, and the only thing we can do is to make them strong enough to endure until the engineer can reach the throttle and close down the engine.

Fig. 1 shows a novel type of wheel suitable for the severe work of a traction plant. It is used on a 600 kilowatt set for power and lighting in the works of Messrs. Workman, Clark & Co., Ltd., Belfast, and was designed by Mr. Chas. E. Allen, a director of that firm. The diameter is 12 feet and the advantages claimed for it, which seem correct, are as follows:

1st. The rim is continuous, and the strength maintained, therefore, practically to the full. 2d. The number of bolts in the rim being much more numerous than spokes, the stresses that occur, due to the bending of the rim between the points of support, are correspondingly less. 3d. The steel disks connecting the rim with the hub are made very strong to resist the great torques of sudden changes of speed, a very important matter in a flywheel for electric traction. 5th. It is exceedingly cheap to make. 6th. The stresses in the arms, due to the cooling and shrinkage of a cast iron wheel are absent from a wheel of this type.

If a larger wheel of this type were made it could be made with the rim in sections, when all the above advantages would obtain, except the first. Another type of wheel, claimed to have been originated by Prof. Sharp, is shown in Fig. 2.

Steel wire of great tensile strength is wound around the periphery of the wheel. With a well-made wheel of this type it is practically safe to run it at three times the velocity of an ordinary cast iron wheel. Hence it would store nine times the energy for the same weight, at the same radius of gyration, as a cast iron wheel.



CROSS SECTION
S.W. = Steel Wire
S.P. = Steel Plates
C.I. = Cast Iron

Fig. 2.

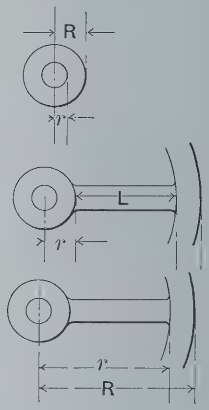


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Fig. 4.

A wheel of this type is used at the Mannsmans Tube Works. About 70 tons of steel wire was wound on the wheel with a tension of about 50 pounds. The flywheel was 20 feet in diameter and ran at 240 revolutions per minute, equal to a peripheral speed of about 250 feet per second. The speed of a cast-iron wheel of the same diameter would be about 100 feet per second.

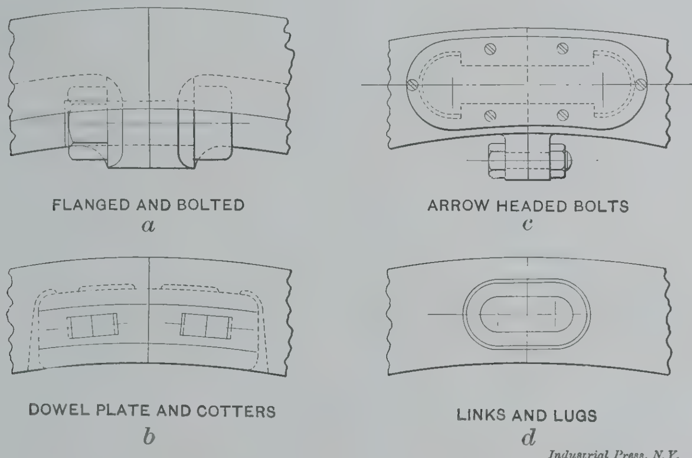
Danger of Flywheels Bursting.

As regards the danger of flywheels bursting, Professor Barr states that it is not realized how dangerous they are and mentions a case in point. It was on an experimental engine. The makers of the flywheel on which an experimental brake was used had, contrary to his wishes, and entirely on their own responsibility, made the flywheel with a solid boss. One evening, during the run, a report like a gunshot was heard and the observers noticed that the flywheel was running out of true. The rim of the wheel was just warm, about as warm as one's hand. The engine was stopped and they found three of the arms out, and six broken. The middle one was open about 3-32 of an inch. There must therefore have been an enormous initial stress in the arms. There were two flywheels on the engine and the makers were told that they must replace both. They said they would replace the broken one with a new one having a split boss and cut the boss of the other wheel. They were warned as to what would happen, but they put the wheel in a slotting machine and before they had cut half way through one side of the boss, the stresses of the wheel completed the job in a manner astonishing to the workman running the slotter.

Great care must be taken regarding test specimens, as a test specimen cast from the same melting as the wheel does not necessarily indicate the same strength as that in the wheel. Test specimens vary also according to the way they are cast, so that a high factor of safety must be allowed in all cast wheels—say from 12 to 15.

Mr. C. A. Matthey, Scotland, says that, considering the ultimate of British cast-iron as 16,000 pounds, it was safe to assume a factor of safety of 8, with a speed of 140 feet per minute; the arms to be cast with the rim but without the hub, thus avoiding cooling stresses, the hub being conscientiously fitted afterwards. This involves entering the arms sideways and not radially into pockets in the hub. He justifies this by exampling the same construction in cane mill practice, where both flywheels and gear wheels are thus made, standing up well under the extremely severe work of these mills. He thinks that the attachment of the arms to the rim, when separate from solid rims, should be such as to drive the rim around without pulling it in toward the center. Let the rim support itself by its own tensile strength without radial pressures at a number of points.

The strength necessary in the arms of a flywheel has little if anything to do with the centrifugal force, and their sections should be proportioned to the driving moments they exerted in storing up energy in the rim and in re-delivering it to the shaft. In certain kinds of engine service a good rule is to make the flywheel arms strong enough to pull up the wheel from full speed to a dead stop in one revolution.



Industrial Press, N.Y.

Fig. 3. Examples of Flywheel Joints.

From Mr. A. Marshall Downie's B. Sc. paper in Trans. of Ins. Engineers and Shipbuilders, Scotland, I quote the following: "The combined cross-sectional area of the arms in well designed wheels of the type used for electric traction, etc., is generally from two to three times the cross section of the rim. The strength of the arms as beams, fixed at the inner end and loaded at the outer end, with the force required to produce an acceleration, either plus or minus, in the mass of one segment, while changing the velocity through the limits specified in the time elapsing between two consecutive points of coincidence of the actual and mean crank effort lines, should also be considered; and this, together with the resistance to shearing by the same load, should not tax the material above one-eighth of its ultimate load."

The fixing of the arms to the hub is usually by means of bolts or cotters and their strength in double shear should be equal to that of the arm in shear or tension, whichever is greater.

Flywheel Rim Joints.

Several forms of rim joints are in use for flywheels. Among the principal ones are the following: *a*, flanged and bolted; *b*, dowel plate and cotters; *c*, arrow-headed bolts; *d*, links and lugs. As illustrated in Fig. 3, the following points must be observed:

a—In flanged and bolted joints, the bolts should be as near the rim as possible, consistently with getting a deep flange. The bolts should be carefully fitted at each end and cleared in the center, so that the stress on them should be tensile rather than shearing. They should all be initially stressed by screwing up, if possible to the same amount.

b—The accurate machining and fitting of the dowel plate and cotter joint is most important. It should be so designed that the strength of the cast-iron, cotters and portion of the dowel plate in shear is equal to the strength of the portion of the dowel plate in tension. The accuracy with which the initial stress in this form of joint can be adjusted is an important feature in its favor.

c—The arrow-headed bolt joint is a shrunk joint, and is open to the objection that the initial stress on the bolts due to the shrinkage is a more or less unknown quantity and the ultimate stress, therefore, indeterminate. The points to be attended to in its construction are accurate machining between the lugs on the bolts and rim, and provision for clearance at the center, for the same reason as noted in *a*.

d—The link and lug joint is also a shrunk joint and subject to the same objections as *c* on that score. If made with the lug projecting, as shown in the figure, it has the advantage that the section of the rim is not diminished at the joint. The increase of weight, however, which such a form necessitates is a good reason for removing the position of the joint nearer one arm. From the experiments of Professor C. H. Benjamin in the proceedings of the American Institute of Mechanical Engineers and from the workings of the engines of the Metropolitan Street Railway, Mr. Downie has drawn the following conclusions:

A good average value for the energy necessary to be stored in flywheels for electric lighting purposes is 2.9 foot-tons per electric horse power; and in traction plants, 4 foot-tons.

Where practicable, cast-iron flywheels should have one-piece rims, but when jointed the best form is the link and lug type, where such can be adopted without inconvenience, and the next best is the dowel plate and cotter. Flanged and bolted joints should be avoided and the best place for a joint is near one arm.

One-piece rim cast-iron flywheels may be run at a peripheral speed of 100 feet per second with the certain knowledge that the factor of safety is not under 12, and link-jointed wheels may also be run at that speed and have a factor of safety of 8. A lower factor of safety should not be used, and flange-jointed wheels should not be run above 70 to 75 feet per second. Built steel wheels may be run up to 130 feet per second. Arms should be joined to rims with large fillets and their fixing to the hub should be carefully fitted.

The best material of its kind should be used in the construction, and homogeneity should be insured as far as practicable by having test bars from each segment cast and proved.

Calculation for Speed Variation.

For the design of flywheels pertaining to lighting and traction the paper of Mr. Downie, with discussion, may be found in the Trans. Ins. Engs. and Shipbuilders, Scotland, and is recommended to the reader.

For regular engine work, however, two sets of formulas are presented from Mr. Foley and from Mr. Marichal. The formulas from Mr. Foley are as follows:

Given permissible variation in velocity above and below mean, to find necessary weight of rim.

$$W = \frac{\text{area piston sq. in.,} \times \text{M. E. P. in lbs.} \times \text{stroke in ft.} \times x \text{ per cent.} \times 32.2 \times C}{(\text{Rim velocity in feet per second})^2}$$

W = weight of rim in pounds.

$\frac{1}{C}$ = fraction that variation of velocity from mean velocity is of mean velocity.

x per cent. = percentage that variation of work from mean resistance bears to mean resistance, viz., to mean work.

Example: Suppose an engine 18 inches by 30 inches stroke to have a flywheel whose diameter is four times the stroke, or 10 feet. Assume the variation of work from mean work to be 30 per cent. What weight should the flywheel rim be so that the variation of velocity shall not be more than $\frac{1}{50}$ on each side of mean velocity?

x per cent. = 30.

$C = 50$.

Area piston = 254.5 square inches.

Stroke = 2.5 feet. We have,

Mean pressure 28.2 pounds.

Mean work or mean resistance during one stroke = 254.5 × 28.2 × 2.5 = 17942.2 foot pounds; and 30 per cent. of this equals 5382.6 foot pounds.

$$\frac{W}{32.2} \times \frac{V^2}{C} = 5382.6$$ foot pounds, and at 120 revolutions per minute the rim velocity would be 62.83 feet, and C being 50, we have

$$W = \frac{5382.6 \times 32\ 2 \times 50}{(62.83)^2} = 2195 \text{ pounds.}$$

TABLE.

$S_1 = .097017\ V^2$ Marichal.

V	S_1	Dia. of Pulley in feet.	Revs. per minute for Rim Speed of feet per second.		
Velocity of Rim in feet per sec.	Tensile Strength of Metal in Rim lbs per sq. in.		150	100	70
50	242.5	4	716.7	477.8	324.7
60	349.3	6	477.8	318.5	222.9
70	475.4	8	358.2	238.8	167.1
80	620.9	10	286.5	181.0	133.7
90	785.8	12	238.8	159.2	111.5
100	970.2	14	204.6	136 4	95.5
110	1173.9	16	179.1	119.4	83.57
120	1397.0	18	159.2	106.1	74.28
130	1639.6	20	143.2	95.5	66.85
140	1901.5	22	130.2	86.8	60.77
150	2182.9	24	119.4	79.6	55.71
160	2483.6	26	110.2	73.5	51 42
170	2803.8	28	102.32	67.2	47.75
180	3143.4	30	95.50	63.7	44.57
190	3502 3	32	89.55	59.7	41.79
200	3880.7	34	84.27	56.17	39.33
210	4278.4	36	79 64	53.10	37.08
220	4695 6	38	75.44	50.29	35.21
230	5132.2	40	71.76	47.77	33.44
240	5588.2	42	68.21	45.47	31.83
250	6063.6	44	65.11	43.41	30.38
260	6558 3	46	62.28	41.52	29.06
270	7072.5	48	59.68	39.79	27.85
280	7606.1	50	57.30	38.20	26.74
290	8159.1	52	55,09	36.73	25.71
300	8731.5	54	53.05	35.37	24.76

D = dia of wheel in feet. $S_1 = .000266 \times (D\,N)^2$ for cast iron.

N = revolutions per min. $S_1 = .000292 \times (D\,N)^2$ for steel.

For tandem engines, the effect is cumulative; hence calculate flywheel for each cylinder and add weights.

For quarter-crank compounds, calculate as for tandems and multiply by 0.625.

For three cranks calculate as for tandems and multiply result by 0.4166.

Formula of Marichal:

d = diameter of cylinder in inches.

S = Stroke of piston in inches.

D = Mean diameter of flywheel rim in feet.

N = Revolutions per minute.

V = Rim speed in feet per second.

P = Maximum pressure on piston in pounds per square inch (difference between initial and back pressure).

F = Fluctuation of speed in per cent. of mean speed.

W = Weight of flywheel in pounds.

S_1 = Strain on rim section in pounds per square inch.

a = Area of rim section required to give rim two-thirds the total weight of wheel.

Then

$$W = 76000\,\frac{d^2\,S\,P}{(D\,N)^2\,F} = \frac{d^2\,S\,P}{V^2\,F} \times 208$$

$$S_1 \doteq .000266\,(D\,N)^2$$

$$a = .068\,\frac{W}{D}$$

$$F = 76000\,\frac{d^2\,S\,P}{(D\,N)^2\,W}$$

Nystrom gives:

P = Radius of gyration of wheel in feet—W = its weight in pounds.

P_1 = Radius of gyration of hub in feet—W_1 = its weight in pounds.

P_2 = Radius of gyration of arms in feet—W_2 = their weight in pounds.

P_3 = Radius of gyration of rim in feet—W_3 = its weight in pounds. (See Fig. 4.)

$$P_1 = \sqrt{R^2 + r^2}$$

$$P_2 = \sqrt{r^2 + r\,L + \tfrac{1}{3}\,L^2}$$

$$P_3 = \sqrt{\frac{R^2 + r^2}{2}}$$

$$P = \sqrt{\frac{W_1\,P_1^2 + W_2\,P_2^2 + W_3\,P_3^2}{W}}$$

N = Revolutions per minute of wheel.

F = Mean total force acting on piston in pounds.

S = Stroke in feet.

f = Irregularity in fraction of speed (N).

$$f = 1 - \sqrt{1 - \frac{338\,F\,S}{W\,P^2\,N^2}}$$

$$W = \frac{338\,F\,S}{P^2\,N^2\,[1 - (1 - f)^2]}$$

$$N = \frac{18.4}{P}\sqrt{\frac{F\,S}{W\,[1 - (1 - f)^2]}}$$

$$P = \frac{18.4}{N}\sqrt{\frac{F\,S}{W\,[1 - (1 - f)^2]}}$$

A gas compressor running at $N = 40$, has a mean effective pressure of 57.87 pounds in the steam cylinder, and 68.68 pounds per square inch in a gas cylinder. Their areas being 113.09 and 38.484 square inches. Therefore $F = (57.87 \times 113.09) - (68.68 \times 38.484) = 3{,}901$ pounds. $W = 2{,}276$ pounds. $P = 1.872$ feet. $S = 1.5$ feet. $N = 40$.

Example—

$$f = 1 - \sqrt{1 - \frac{338\,F\,S}{W\,P^2\,N^2}} = .081\,N$$

* * *

The first vessel to surpass the *Great Eastern* in length and displacement was the *Oceanic*, placed in commission in 1899, and since that time there has been a gradual increase up to the present *Cedric*. One reason why the *Great Eastern* was a commercial failure was that sea ports, especially those of the United States, were too shallow to allow her entrance without danger of grounding. But a more important reason was the inability of the shops of that day (1858) to produce boilers and engines commensurate with the requirements of so large a boat.

Near the end of the Civil War the Navy Department built the *Wampanoag* with a single regard to speed high enough to enable her to catch privateers. But her boilers were built for a pressure of only 32 pounds. The *Cedric*, which is designed to make about the same speed, will carry 210 pounds of steam. The plates were small and heavy because rolls were small and the material (iron) required much thickness to give it strength. The result was enormously heavy machinery. The introduction of compound, triple expansion and quadruple expansion engines is in great measure due to the production of cheap steel and the possibility of getting sufficient steam power without sinking the steamer with boilers. Comparing the *Wampanoag* with the *Charleston*, Naval Constructor Hollis has pointed out that the gain in twenty years consisted in reducing the weight of engines, boilers and coal from 46 to 36 per cent. of the displacement. The engine of the United States steamship *Powhatan*, built fifty-four years ago, weighed 508 tons, or 972 pounds per horse power.

HEAT RESISTANCE THE RECIPROCAL OF HEAT CONDUCTIVITY.

In a paper, submitted by Mr. William Kent, at the December, 1902, meeting of American Society of Mechanical Engineers, he states that during a study of heat-conducting power of various substances used for heat insulation, he has discovered that the comparison of results obtained from different experimenters would be facilitated if the results were reduced to a common basis of coefficients of heat resistance, instead of being expressed in the number of British thermal units transmitted per hour, or per day, by each square foot of surface per degree of difference of temperature of the air adjoining the two surfaces.

The use of these figures representing *resistance* instead of those representing *conductivity* is analogous to the usual practice in electrical calculations, the chief advantage being that resistances in series may be added together to obtain total resistance, while the conductance of several wires or other bodies acting in series cannot be added to obtain the total conductance. Thus, if R_1 and R_2 are the resistances of two wires arranged in series, or one after the other, their total resistance is $R_1 + R_2$. If c_1 and c_2 are the conductances of these two wires, or the reciprocal of the resistances, $= \frac{1}{R_1}, \frac{1}{R_2}$, respectively, their total conductance is not $c_1 + c_2$, but

$$1 \div \left(\frac{1}{c_1} + \frac{1}{c_2}\right)$$

The meaning of this, as applied to heat conductance, may be made clear by considering the following hypothetical case. Suppose that in testing the heat-conducting power of a certain substance, say a sheet of cardboard, we find that its conductivity, expressed in British thermal units per square foot per hour per degree of difference of temperature is 0.8, and that a sheet of felt tested in the same way gives the figure 0.4; placing a felt between two boards we obtain 0.2; two felts between three boards, 0.1143; three felts between four boards, 0.08; four felts between five boards, 0.0615.

Authorities on the subject of heat transmission generally agree that the resistance to the passage of heat through a plate consists of three separate resistances; viz., the resistances of the two surfaces and the resistance of the body of the plate, which latter is proportional to the thickness of the plate.

A complete set of experiments on the heat-resisting power of heat-insulating substances should include an investigation into the difference in surface resistance when a surface is in contact with the air and when it is in contact with another solid body. As the result of a series of such experiments the writer has prepared a table giving the coefficient of heat resistance for a great number of combinations of boards, cork, pitch, paper, etc., from which their relative values for refrigerator and cold storage construction purposes can be readily determined.

From the results of German experiments the following formula has been derived for the heat resistance of brick walls

$$C = 0.70 + 0.20\,t;$$

in which $C =$ heat resistance; $t =$ thickness of wall in inches.

In the following table, calculated by this formula, the value of C differs only slightly from that derived by the original experiments:

Thickness.	C.	K.	Thickness.	C.	K.
4-in	1.50	0.667	24-in	5.50	0.182
8-in	2.30	0.435	28-in	6.30	0.159
12-in	3.10	0.323	32-in	7.10	0.141
16-in	3.90	0.256	36-in	7.90	0.127
20-in	4.70	0.213	40-in	8.70	0.115

K in the table equals the B. T. U. transmitted per hour per square foot of surface per degree F. difference of temperature.

In conclusion the writer proposed the adoption of a standard for expressing heat resistance or the heat insulating power of various substances as follows:

The coefficient of heat resistance of a substance is equal to unity divided by the number of British thermal units transmitted in one hour by a slab 1 square foot in area, and 1 inch thick per degree Fahrenheit of difference of temperature between the two faces of said slab, both surfaces being exposed to still air.

It should be noted that the coefficient of resistance thus defined will be approximately a constant quantity, for a given substance under certain fixed conditions, only when the difference of temperature of the air on its two sides is small—say, less than 100 degrees Fahrenheit. When the range of temperature is great, experiments on heat transmission indicate that the quantity of heat transmitted varies not directly as the difference of temperature but as the square of that difference. In this case a coefficient of resistance with a different definition may be found—viz, that obtained from the formula $a = \frac{(T—t)^2}{q}$, in which a is the coefficient, $T—t$ the range of temperature, and q the quantity of heat transmitted, in British thermal units per square foot per hour.

* * *

A REVIEW OF THE STEAM ENGINE IN 1829.*

G. L. F.

Hoene Wronski, a scientist of Polish origin, who died in Paris in 1853, published a number of works, among which was a pamphlet issued in 1829 entitled "An examination of the actual state of the steam engine, from the standpoint of mechanics and manufactures, in order to arrive at the solution of the problem presented by these machines; with a supplement giving a rigorous mathematical theory of steam engines founded on a new theory of fluids."

In this now rare work, Wronski examined the general condition of mechanical industry. The author lays down twelve principal points that stand out more prominently than others in the progressive development of the steam engine. The first lies in the actual use of steam by its expansion and condensation, as proposed by Papin but first realized by Savery in 1696. The second, though purely a negative one, is the invention of the safety valve by Papin in 1682.

The realization of the movement of the piston in a cylinder by the alternating action of the expansion and condensation of the steam, as effected by Newcomen and Cawley, constituted the third great step in the progressive development of the steam engine; a patent for the device having been issued in 1705.

The movement of a piston in a cylinder, obtained by the action of high-pressure steam and without condensation, as proposed by Leupold in 1724, was the fourth step. The saving in steam consumption obtained by the various inventions of Watt, especially the condensation outside the cylinder was the fifth step. The sixth was the regulation of the direct action of the steam upon the piston in the place of air. This was also due to Watt.

The seventh great step of advancement may be represented by the aggregation of the mechanical means used for the production of steam, for taking it into the cylinder, for governing its action, as well as for the transmission of the action of the piston to the shaft or principal motor, and to the different pieces that go to make up the moving parts of the machine. These improvements are due to a number of persons, among them Boulton and Watt.

The realization by Watt of the cut-off, by which it became possible to use the steam expansively in a part of the cylinder, was evidently the eighth fundamental step along the line of improvement of the steam engine. The ninth lies in the utilization by Hornblower of two cylinders to obtain the two distinct actions in the use of steam at the same time, namely: the constant action of its continuous pressure and the variable action due to expansion which was equally continuous.

The combination of the two-cylinder engine of Hornblower with high-pressure steam, made by A. Woolf and serving as a sort of transient machine connecting the old condensing engines with the later high-pressure engines, can surely be regarded as the tenth essential step in the evolution of the steam engine.

The determination by English and French physicists—among whom the name of Dalton is prominent— of the laws governing the phenomena presented by the action of steam can well be regarded as the eleventh step in the progress of the steam engine. Finally, the use of high-pressure steam without any condensation, as firmly established in Trevethick's engine, and which became of special value in the propulsion of carriages, was the twelfth and last step in the development of the engine of the time.

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* Translated from Bulletin de la Société des Ingénieurs Civils.

Wronski would have liked to have seen a thirteenth step—the substitution of rotary for reciprocating engines, in which he saw an enormous loss of power, due to the impulse of the piston and all of the moving parts of the machine being so frequently stopped and started. He also says, "It is generally recognized by all engineers that the total output of the best steam engines, such as they are building to-day (1829), is only one-half of the energy put into them by the steam." But surely, however great the frictional resistance of the engine might have been, it does not seem possible that it could have been equal to one-half the total energy of the steam.

Although Wronski's ideas may seem to us to be very extraordinary, we must not lose sight of the fact that they were shared by a large number of people at that time; and it is these incorrect ideas as to the economy of the reciprocating engine that led to the long-continued attempts to build an engine in which the rotation was accomplished direct from the action of the steam.

The author laid down seven conditions that should be fulfilled in the construction of a steam engine. These are as follows:

1. It should occupy the least possible amount of space; 2, in this minimum of space it should have the greatest possible amount of cylinder space for the action of steam, and should, at the same time, be of the lowest weight consistent with the requirements of strength and freedom from breakdowns; 3, its erection should be independent of the place of construction, so that it may be easily transported in sections; 4, its construction should be of the simplest character and consist of the minimum number of pieces; 5, the machine should be capable of being built at low cost and repaired at any place by ordinary machinists; 6, it should be so self-contained that its power may be rendered available without the use of wheels, cranks or other methods of transmission. As a consequence of this it should be possible to run it horizontally, vertically or in any other position in which it may be put; 7, finally, it should have a continuous and regular action and utilize the steam consumed to the utmost advantage and with the minimum losses from internal friction.

In this and what precedes there is little that is not in accord with modern practice, but the author then goes on, in a supplement, to elaborate mathematical conditions of steam-engine work, in which he shows that the principles of cylinder condensation were not known; for it was not until 1838 that Thomas gave a true solution of the phenomena of cylinder condensation due to the action of the walls of the same and the piston.

Although Wronski was disposed to believe that the ultimate improvement of the steam engine lay in the direction of the rotary machine, he did not believe at all in the possibilities of the reaction machine of the Hero type. It is quite natural that with the lack of accurate data in 1829, the author should have taken erroneous positions in regard to many points; but in his selections of the twelve great steps in the development of the steam engine he did pick out the most important features that had been brought out up to that time, while his essential conditions for a successful engine might almost be adopted by the designers of the present day.

* * *

The Bureau of Statistics has issued a summary of the growth of the manufacturing industries of the country since 1870 and of the progress in agriculture, including products for home and foreign consumption. Since 1870 the population has increased practically 100 per cent. Agricultural production has increased 92 per cent., or almost the same rate as the increase in population, while the production of manufactures has increased 209 per cent. Of the agricultural products we now export 132 per cent. more than in 1870 and the exportation of manufactures has increased 538 per cent. Comparing figures with 1850 the production of manufactured products is now 13 times as great, while the population has increased but a little over three times in that period.

STEEL CASTINGS.*

SPECIFICATIONS, USES, PROCESSES, RELIABILITY.

The raw materials that usually enter into the making of steel castings are steel scrap, pig iron and iron ore. The scrap consists of the crop ends of plates, shapes and forgings and the borings and turnings from the machine shop. The bulk of the furnace charge is scrap, the proportion of pig being about one-fifth at the beginning of a run—that is, immediately after a furnace has been rebuilt—and increasing up to nearly three-tenths at the end of the run, when the furnace lining and brick work generally are getting so slagged and burnt out as to require renewal. These proportions are of acid steel, basic steel using larger quantities of pig. The amount of iron in the ore is a secondary consideration, the ore being used chiefly for its oxygen, which comes into play in oxidizing the metalloids carbon, silicon, sulphur, phosphorus. The proportion of ore required in a charge depends upon the character of the other ingredients; ordinarily in an acid furnace from one to two, or two and a half per cent. would be used. There have been cases where scrap could not be procured, and the charge has been made up, of necessity, entirely of pig and ore, over three-fifths being pig. Hematite ore is the variety most used, and is obtained in large quantities in the Lake Superior region in this country and Canada; much of it is also imported from Cuba, Spain and elsewhere.

The amount of carbon combined with iron makes one difference between wrought iron and steel and between steel and cast iron. A second and equally important difference is the method of manufacture and the resulting properties and character. Wrought iron is soft and fibrous; cast iron is hard, crystalline and brittle; steel comes in anywhere between.

Basic steel is used in making castings, but not so generally as the acid product. Cheaper raw materials can be used in making basic steel, and phosphorus, the element chiefly objected to, can be nearly eliminated. It is more expensive than acid steel, however, and fewer heats per run of furnace can be turned out. With acid steel the number of heats will reach nearly three for each twenty-four hours, depending upon the size of furnace and character and quantity of work.

Open Hearth Furnaces.

These raw materials are melted down in a reverberatory furnace with gaseous fuel distilled from special bituminous coals in gas producers. Under each end of the furnace is a pair of regenerators—one for air, one for gas—which communicate with the furnace on one side and on the other with flues leading to the sources of supply of gas and air to the chimney. Reversing valves are located at the point where the flues meet, and about every twenty minutes, while the furnace is in operation, the valves are shifted and the currents of air and gas turned in the opposite direction. Each regenerator is nearly filled with fire brick built up in such an open checkerboard manner that the air and gas find their way among and through them, absorbing heat from them on their way to the hearth, and, when spent, giving up heat to those in the opposite regenerators.

With this type of furnace a temperature of 4,000 degrees Fahrenheit can be attained, but as the supply of gas and air is at all times under control the temperature can be made whatsoever may be desired. The process in the furnace will be acid or basic according to the character of the furnace lining—basic linings and additions being used in one case and an acid lining, such as ordinary fire brick and fire clay, in the other.

Specifications.

Castings requiring annealing are placed in annealing furnaces, where they are gradually and uniformly heated up to temperatures depending upon the composition of the metal and varying between 1,200 and 1,600 degrees Fahrenheit, kept soaking at the maximum temperature for a time determined by their size, and allowed gradually to cool without exposure to the air. When cold the coupons are detached and the necessary test specimens cut from them and machined accurately to required size. These specimens are then broken or bent in an approved testing machine according to the specifications prescribed. The latest specifications of the Bureau of Steam Engineering are here given in full:

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* Abstract from Journal of the American Society of Naval Engineers, February, 1903.

(1) The physical and chemical characteristics of steel castings must be in accordance with the following data, to meet the requirement of the Bureau of Steam Engineering of the Navy Department: Class A castings, annealed; tensile strength 80,000; elastic limit 35,000; per cent. elongation in two inches, 15; reduction of area, per cent., 20; maximum phosphorus, .06; cold bend, ½-inch radius, through 90 degrees. Class B castings, annealed: Values of above specification change to the following, taken in order: 65,000; 30,000; 18; 25; .06; through 120 degrees. There is also a third class, called Class C, which will ordinarily be subject to surface inspection only at the building yard. They will not be tested unless there are reasons to doubt they are of a quality suitable for the purpose for which they are intended. The inspector will select a sufficient number of castings and have them crushed, bent or broken and note their behavior and the appearance of the fracture.

(2) *Kind of material.*—Steel for castings may be made by the crucible, open-hearth, Bessemer, Tropenas or any other process approved by the Bureau of Steam Engineering. The material must be of uniform quality throughout. In case of doubt on this point, the inspector will have drillings for complete analysis, taken from the surface and from the center of the thickest parts. In all cases analyses will be made for phosphorus, and no casting shall contain more than six one-hundredths of 1 per cent.

(3) *Treatment.*—All castings, except those of Class C, shall be annealed, unless otherwise directed. If castings are subjected to any special treatment, the inspector will make such additional tests as he may deem necessary to see that the treatment has left the material of uniform character throughout. In case the results obtained by the first tests do not conform to the specifications, the manufacturer may re-treat the castings and submit additional pieces for test.

(4) *Surface and other defects.*—All castings shall be thoroughly cleaned before they are presented for inspection. They shall be sound, free from brittleness, injurious roughness, sponginess, pitting, porosity, shrinkage and other cracks, cavities, foreign substance, and all other injurious defects. Particular search shall be made at the points where the heads or risers join the castings, as unsoundness at such points is likely to extend into the castings.

(5) *Test pieces.*—Sound test pieces shall be taken in sufficient number to thoroughly exhibit the character of the metal in the entire piece from each of the following castings, viz.: Shaft struts or brackets, main cylinder or valve-chest liners, main pistons and followers, eccentric, reversing and rock shaft arms, crossheads, bedplates, columns of main engines and main air pumps, shaft couplings, and all large castings weighing over 200 pounds. All other castings may be tested by lots, as follows: A lot shall consist of all castings from the same heat, annealed in the same furnace charge. From each lot two or more tensile and one or more bending test pieces shall be taken, and the lot passed or rejected on the results shown by the tests. The test pieces may, at the discretion of the inspector, be cut either from coupons to be molded and attached to some portion of the casting, or else from sinking heads, in cases where such heads of sufficient size are employed. Coupons are to be attached so as not to interfere with the successful making of the casting, but at the same time to show the quality of the material. In the case of castings tested by lots, and if the manufacturer so desires, the test pieces may be taken from the body of a casting selected by the inspector from the lot. In no case shall the coupons be detached from their castings before they are stamped by the inspector. In special cases where the attachment of a coupon would be liable to injure the casting, the coupon may be cast with small runners to the gate, or separately in the same flask, so that they may be easily identified when the casting is knocked out of the sand. In all such cases the sanction of the inspector must first be obtained.

(6) *Percussion test.*—Large castings shall be suspended and hammered all over with a hammer weighing not less than 7½ pounds. No cracks, flaws, defect or weakness shall appear after such treatment.

Uses of Steel Castings.

Steel castings are used for cylinder and valve-chest covers, for pistons, crosshead guides and slippers, bearing caps and shoes, eccentric sheaves and straps, rocker arms, thrust-bearing boxes and collars, bedplates and housings and other parts of main and auxiliary machinery; for boiler headers, manifolds, drum ends, dry pipes, manhole and handhole doors and other parts of boilers; anchors, anchor davits, hawse pipes, chocks, mooring and towing bitts, stems, stern posts, stern tubes, shaft brackets, manhole covers and other parts of ships' hulls, gun mounts, parts of dynamos and motors. Their use in ship construction and aboard ship is thus seen to be a large and important matter.

The cast-steel girders for the 16-inch army gun carriage, the gun now being tested at the Sandy Hook proving grounds, measure each 33 feet by 17 feet by 5 feet, and will weigh about 100,000 pounds apiece; the carriage presents problems in transportation from the foundry to the arsenal at Watervliet on account of size and weight. A large casting turned out in the eastern part of Pennsylvania for a hydraulic forging press to be set up in the western part of the same State required about 320,000 pounds of metal from six open-hearth furnaces to pour it.

Cire Perdu Process.

Some five hundred years ago, more or less, a method of casting bronze statuary in which wax played a chief part was evolved and practiced. A mass of clay was built up into a shape roughly resembling the desired figure, and this was coated heavily with the wax preparation. This wax was then cut and carved into the finished shape, and, in its turn, covered with a heavy layer of clay. By sufficiently heating the mass the wax was melted out, leaving a perfect mold and core, and the molten bronze was then run into it and the desired statue thus produced. To-day there is a patented process in use, for turning out a large number of steel castings of the same size and shape, which makes use of this idea. A master mold of cast iron is made, and a number of patterns are cast in this of an alloy fusible at low temperature, such as a mixture of antimony and bismuth. The damp molding sand is thrown at and around these alloy patterns by pneumatic apparatus, and the molds, thus quickly and cheaply made, are then dried in the usual way. The heat of the drying ovens melts the patterns, and the fluid alloy runs out at the bottom of the mold and is caught to be used again. The bottom of the mold being closed, fluid steel is poured in, and when the castings are shaken out very little cleaning is required to present them ready for service or for the machine shop.

Are Steel Castings Reliable?

A forged or rolled object is worked down from a billet which previously was hammered or pressed down from an ingot or part of an ingot, and during these stages of manufacture the metal is more or less thoroughly squeezed and pressed and caused to flow upon itself in various directions, and all parts, inside and out, receive some heat and power treatment, so that the impression grows in the minds of those who manipulate the forgings and of those who witness the manipulation that the accepted objects are free from weakening defects; the assurance of their trustworthiness is positive.

In the case of castings no such certainty or confidence is created. A steel casting may come out of the final cleaning process a thing of beauty, the physical and chemical tests may gladden the heart, the required machining may show up no flaws, yet the fear will not down that below its surface somewhere a treacherous cavity or other weakness may some day get in its deadly work—a day when most dependence is necessarily placed upon the casting, when most damage may result from its failure to do its duty. However, the industry is steadily improving; all things human, especially all things American, are marching forward, and in time this fear will disappear, and eventually as much reliance be placed in a steel casting as in a hammered, pressed, rolled or drawn object, but the question may now be asked, Is that time in sight?

* * *

The Treasury Bureau of Statistics report that for the first three months of 1903 the Beaumont oil fields shipped 16,428 cars loaded with petroleum, or 2,791,483 barrels.

BLOWING ENGINE FOR THE SHARON STEEL CO.

The large blowing engine shown in the accompanying halftones and line cuts, Figs. 1 to 5, is one of a lot of six being built by Mackintosh, Hemphill & Co., Pittsburg, Pa., for the Sharon Steel Co., Sharon, Pa., one of the constituent companies of the United States Steel Corporation. It is a 30-inch and 60-inch and 60 x 72-inch Corliss horizontal, cross-compound, condensing engine, having a capacity of 30,000 cubic feet of free air per minute at the normal blast pressure of 18 pounds and a steam pressure of 150 pounds per square inch, running at a speed of 60 revolutions per minute. The blast pressure may be increased, however, to 25 pounds in cases of emergency, and the speed may be varied up to a maximum of about 70 turns per minute.

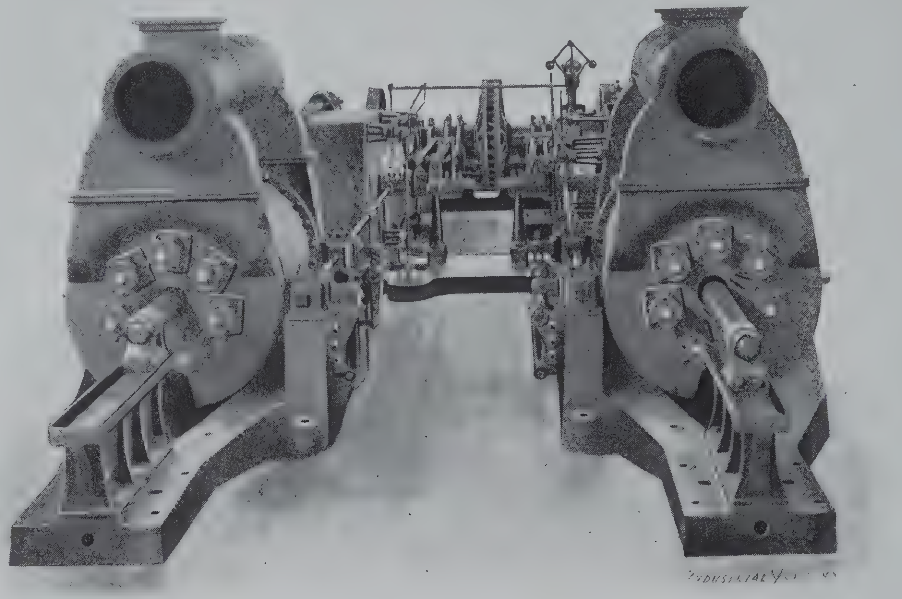


Fig. 1. End View of Blowing Cylinders showing Tail-rod and Guides and Caps to Dash-pots of Outlet Valves.

The general design of this blowing engine, is typical of the rugged strength and massiveness characterizing the rolling mill machinery built by this firm. Mackintosh, Hemphill & Co., we may mention in this connection, is one of the oldest machinery building and founding concerns in Pittsburg, having been originally the famous Fort Pitt Foundry which was established in 1810. A brief account of the early history of this foundry was given in the April, 1901, issue. To revert to the matter of design it is well understood that reliability of this class of machinery, which means the ability to run week in and week out with a minimum of stoppages for repairs, is of first importance and is a condition absolutely necessary in the economical operation of a blast furnace. A serious breakdown of a blowing engine may easily mean a loss of thousands of dollars in loss of product and damage to the furnaces. This being the case we shall look at the design of this engine with renewed interest since it is a foregone conclusion that it is one that is known to be of proven merit.

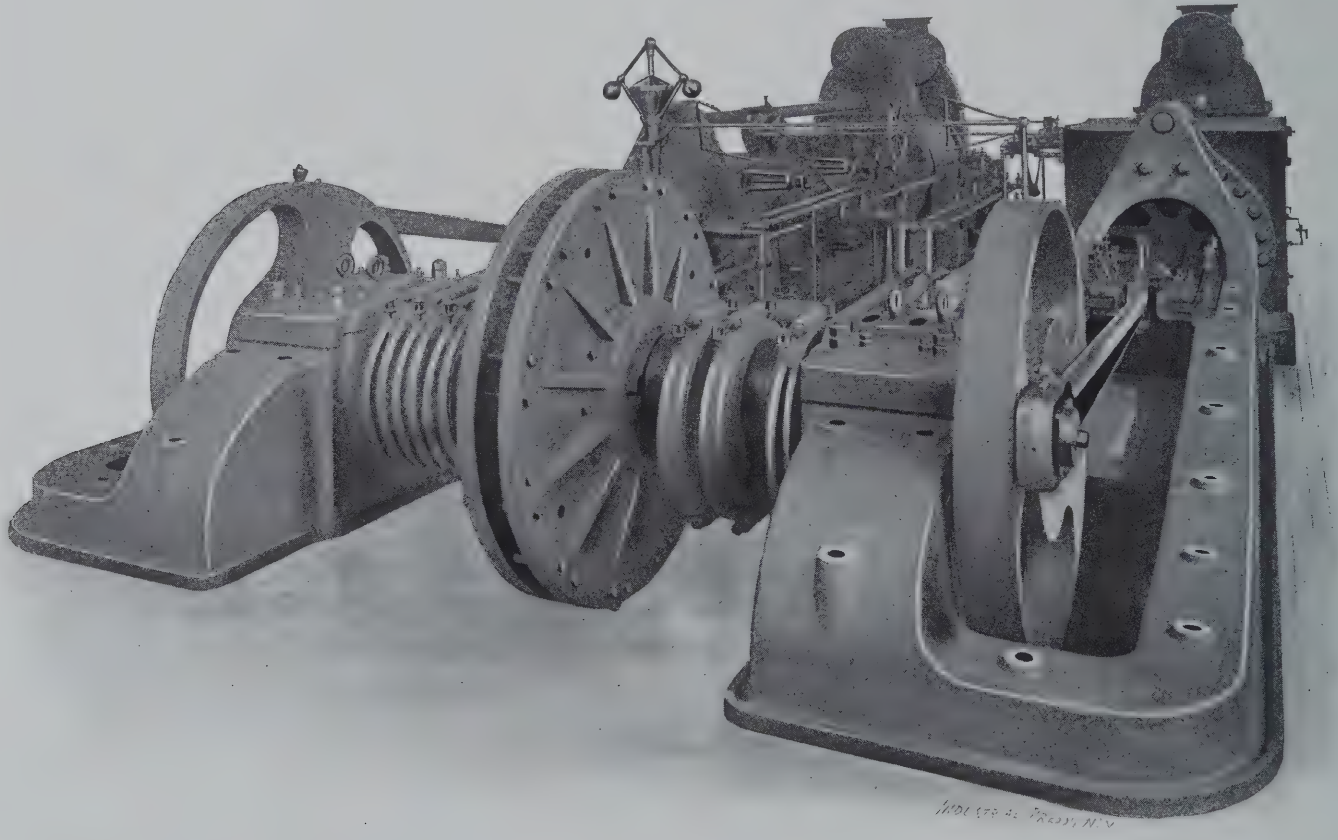


Fig. 2. Blowing Engine built by Mackintosh, Hemphill & Co. for Sharon Steel Co. Capacity, 30,000 cubic feet of Free Air per minute.

In the elevation, Fig. 3, the construction of the frame may be profitably studied as a problem in design. This part of a machine 77 feet 6 inches long, which must be rigidly connected in all parts, yet free to expand and contract with variations of temperature in the component parts, is a most troublesome one to the designer of this class of machinery. In fact it may be safely stated that in all probability expansion and contraction stresses have been responsible for more failures of rolling mill engines and blowing engines in the past than any other cause. In this design the front part of the frame carrying the main bearings, is connected to each blast cylinder by means of a 7-inch tie-rod at the top, and the extended base of the blast cylinder, at the bottom. The steam cylinders are connected to the front casting so as to be perfectly free to expand and contract longitudinally without affecting the integrity of the frame in any degree.

Six separately adjustable eccentrics are provided for operating the Corliss valve motion and the inlet valves of the compressor cylinders. In the plan view it will be observed that the connections between the eccentrics and the steam valves are uniformly in a straight line, which does away

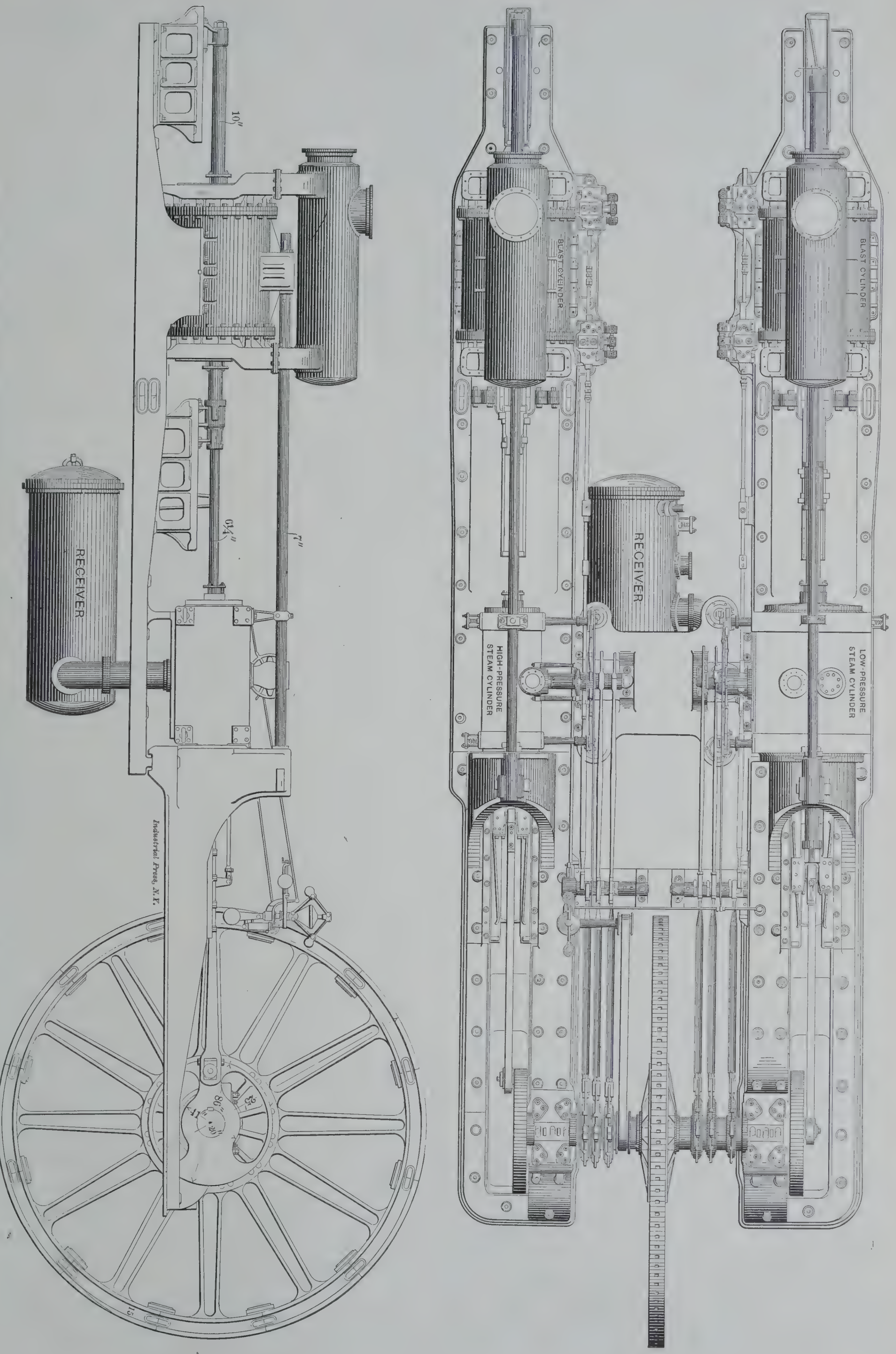
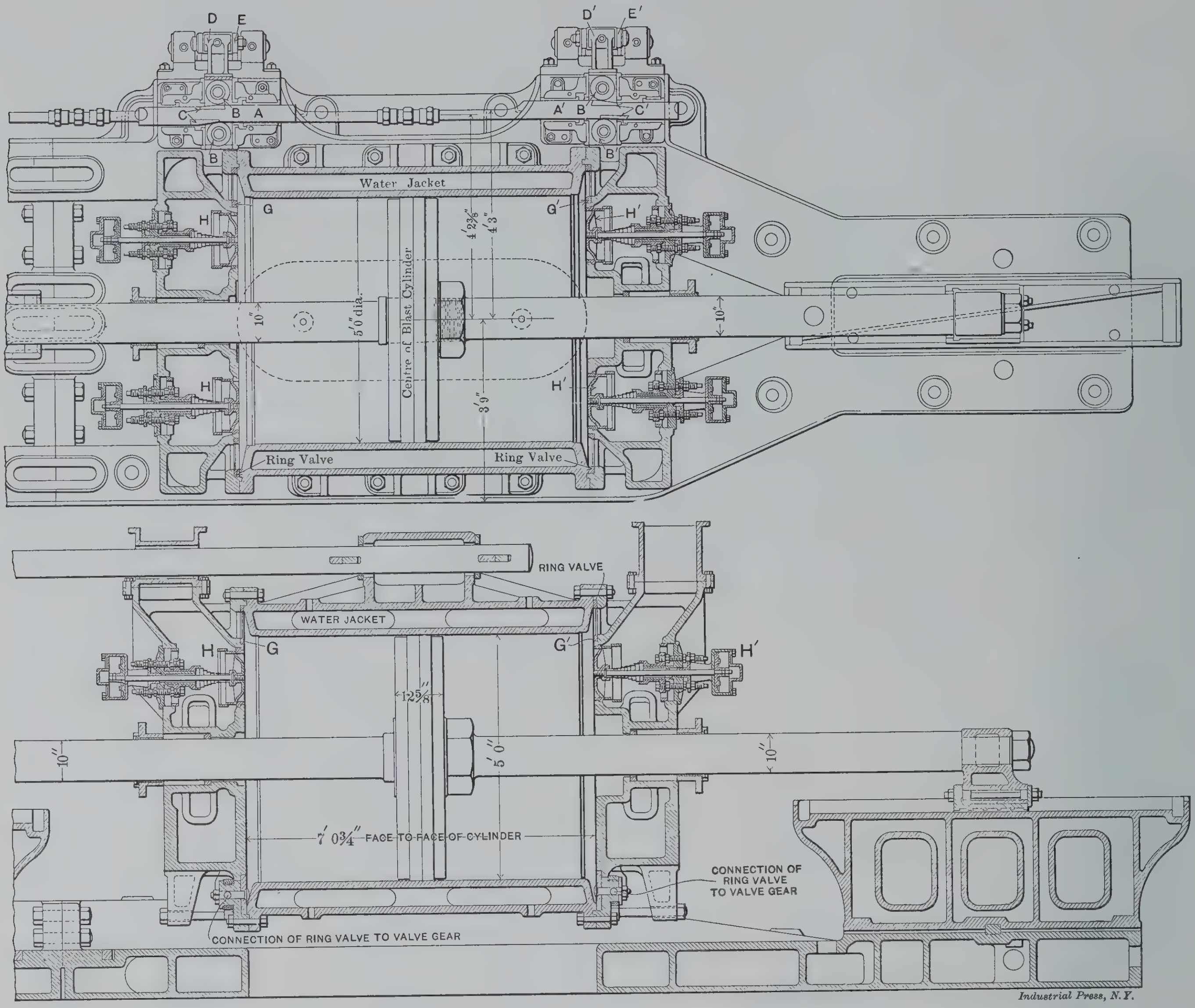


Fig. 3. Plan and Side Elevation of Blowing Engine. Total Length over all, 77 feet 6 inches. Cross-compound Condensing Engine with Corliss Double Eccentric Valve Gear.



Industrial Press, N.Y.

Fig. 4. Plan and Side Elevation of Blast Cylinder showing Circular Grid Inlet Valves, Mechanically Operated, and Poppet Outlet Valves.

with all twisting, canting effects that are unavoidable when the connections are not direct. The steam inlet valves are operated by one eccentric on each side, and one each for the exhaust valves. This of course, gives the well-known advantage held by the double-eccentric Corliss engine of having an extended range of cut-off, and makes it possible to operate their engines for a wide range of speed and blast pressure. The receiver between the high- and low-pressure cylinders is also a reheater, which feature is supposed to materially lessen the condensation losses in the low-pressure cylinder.

The air outlet valves of the compressor cylinders, are of the single poppet type, 12 inches in diameter, and there are seven in each cylinder head arranged in a circle close to the piston rod. They are held to their seats by heavy volute springs, and are provided with dash-pots to prevent slamming when forced open by the pressure developed in the cylinder. The inlet valves, which are mechanically operated as already stated, are of the circular grid type, 5 feet 5½ inches mean diameter, and are set between the heads and cylinders surrounding the space occupied by the poppet outlet valves. The inlet valves are oscillated in a plane at right angles to the cylinder axes which makes their movement by a simple reliable mechanism, an interesting feature. The construction of the compressor cylinders and of the air inlet valve motion, is shown in the plan and elevation sections, Fig. 4. A cross section, Fig. 5, gives further details.

The ports covered by the circular grid valve are 1 11-16 inch, and the bridges 2 3-16 inches mean width. The mean travel, that is, the travel on a radius equal to that from the center of the valve to the center of the valve motion connecting-rod pin, a distance of 2 feet 8¾ inches, is 1.98 inch. This movement is effected through the valve connecting-rod *F*, and the lever *E*, Fig. 5. The lever *E* is pivoted and is connected at the upper end to a transverse slide *D* which is operated by the longitudinal slide *A*, Fig. 4, which of course is directly connected to the eccentric rod, and has hardened steel insets *C* set at an angle and engaging the rollers *B B*, and are mounted on the transverse slide *D*. The proportions of the two arms of the lever *E*, are such that the movement imparted to the transverse slide by the longitudinal slide, is multiplied about two times, thus reducing the actual movement of the transverse slide to something like one inch. Both the longitudinal and transverse slides run in babbitted bearings. The rollers *B B* are of large size, being 6 inches diameter and 4 inches thick.

It is scarcely necessary to point out that the air cylinder piston is carried free of the bottom of the cylinder by the tail rod, which in turn is borne up by slippers running on guides. This feature is of great importance in the operation of a compressor, as it saves great wear on the cylinder and much loss of power by friction. The outside bearings are obviously in a position to be much more effectively lubricated than the interior of the cylinder. The piston rods are secured in the middle slipper by double keys. It will also be noted that the blast cylinders are water-jacketed which we believe has not been a common practice hitherto. The clearance is reduced to 1¼ per cent.

The flywheel is of the built-up type, 25 feet diameter and weighing 40 tons. The rim sections are connected together by shrunk links on the sides and inner circle, thus giving three links for each joint. The crank disks are steel castings 86 inches diameter.

* * *

A summer school for artisans is to open at the University of Wisconsin, Madison, July 6th. Practical courses in mechanics and engineering, and shop work, are to be given.

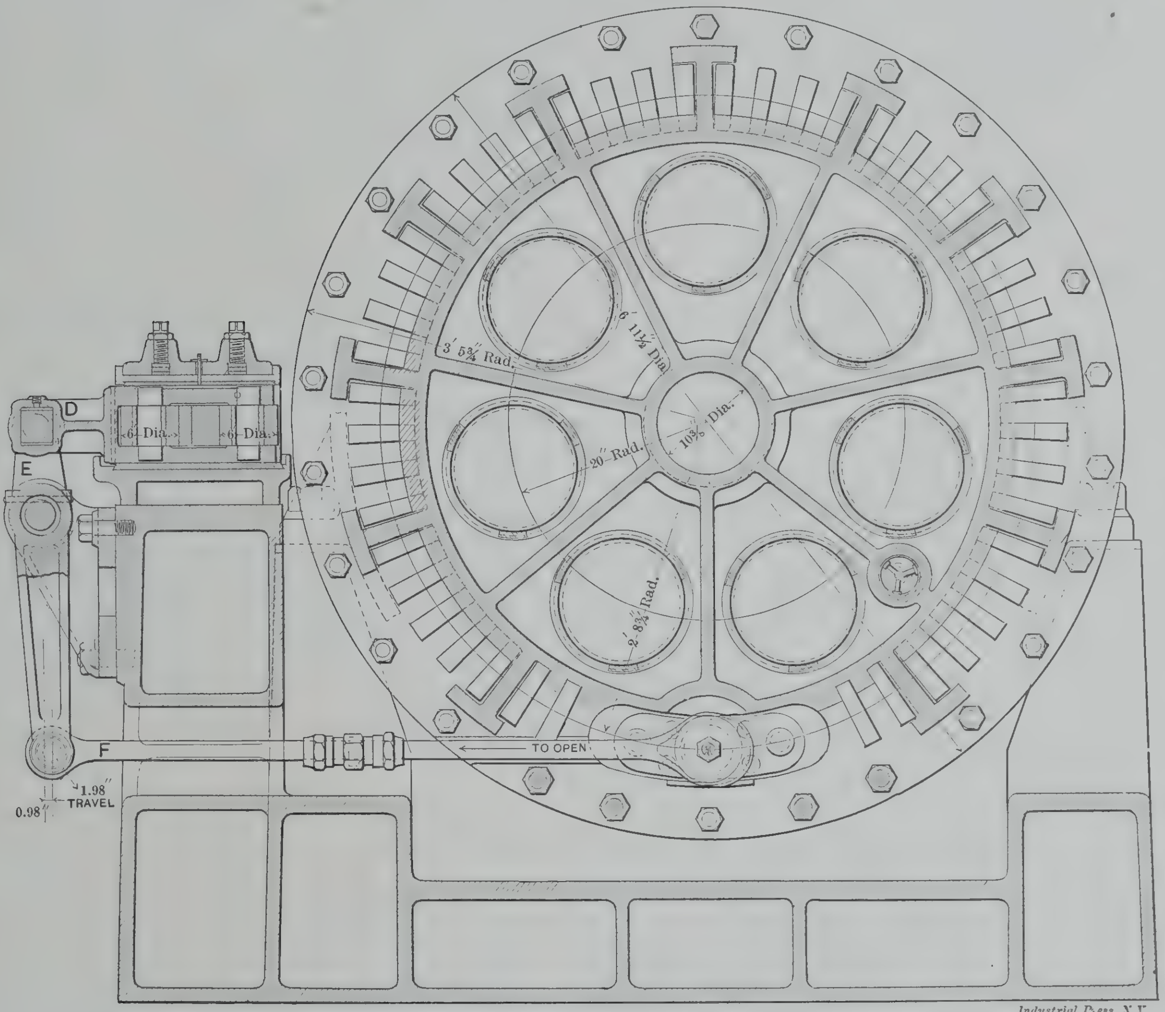
PISTONS AND PACKING RINGS.—5.

"SNAP RINGS."

J. H. DUNBAR.

The snap ring made of cast iron is the most popular packing for piston heads just now, and bids fair to continue to be so for a long time to come. This is due principally, to its cheapness, ease of renewal, etc., and a widespread sentiment that it is "good enough." While some find fault with it on account of its liability to break, or because of an occasional one which has been badly proportioned, poorly made, or which for some other reason has not had a chance to be satisfactory, the snap ring nevertheless is holding its own against the field.

Packing rings are seldom made of any other material than cast iron, but their relative proportions vary largely. There are, however, but two types of snap rings, viz., the one made of uniform section, and the eccentric. These are shown in Figs. 1 and 2, respectively. Each is made about one per cent. larger than the cylinder, and has a corresponding amount cut out of its circumference, so as to let it slide freely in the cylinder, when the ring is sprung into it. Their thickness and radial dimension are great enough to allow them to be sprung over the follower, or flanges of the piston, and "snap" into their grooves, without too much danger of breaking in the operation. About three per cent. of their diameter is a practical thickness for Fig. 1, making a ring for a 20-inch cylinder ⅝-inch thick, and 20 3-16 inches outside diameter. Fig. 2 has the same diameter, but ¾ and ⅜ at its thick and thin sides respectively.



Industrial Press, N.Y.

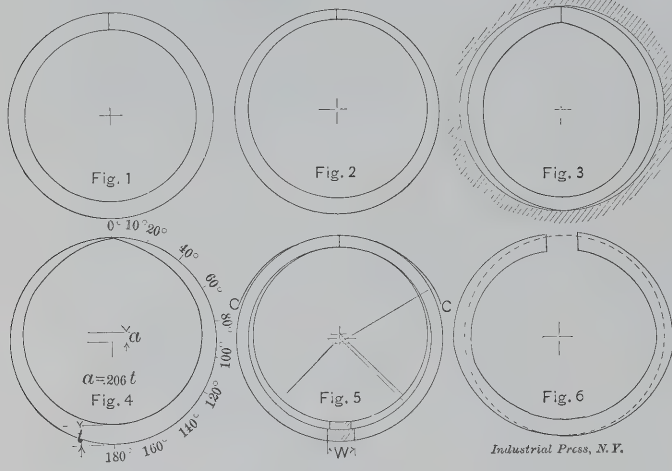
Fig. 5. End View of Circular Grid Inlet Valve and Operating Mechanism. (See Opposite Page.)

It will be seen that rings of uniform section, when turned larger than the cylinder, and cut and sprung into it, will bear only on two opposite lines, top and bottom, as shown in Fig. 3. It has been believed that rings like this will soon wear a cylinder oblong; hence many remedies have been proposed for the ailment. The eccentric ring has been mentioned as a panacea for the complaint, and when made according to Prof. S. W. Robinson's formula, it is theoretically perfect in all respects. It is shown in Fig. 4, and is laid out from the figures in the following table, which are copied from Unwin's "Elements of Machine Design."

10 degrees from the top, thickness is .197 times that at bottom.
20 degrees from the top, thickness is .311 times that at bottom.
40 degrees from the top, thickness is .489 times that at bottom.
60 degrees from the top, thickness is .630 times that at bottom.
80 degrees from the top, thickness is .745 times that at bottom.
100 degrees from the top, thickness is .837 times that at bottom.
120 degrees from the top, thickness is .908 times that at bottom.
140 degrees from the top, thickness is .960 times that at bottom.
160 degrees from the top, thickness is .990 times that at bottom.
180 degrees from the top, thickness is 1.000 times that at bottom.

In designing a ring from this table, first draw a circle to represent the diameter that the ring is to be turned and decide upon the bottom, or thickest part, say ¾ inch for a 20-inch ring. Now space the circumference as in Fig. 3, then beginning with nothing at the top, make the thickness at 10 degrees, .197 × ¾ = .197 × .75 = .14775 inch, say 5-32ds, and so on around the ring. It will be found that if we set the needle point of our dividers above the center of the outside of the ring (.206 times the thickness of the ring at the bottom), the other leg of the dividers may be set to sweep through two-thirds of the points that have been made from the table, so there is no need of calculating further down than 80 degrees. In making the ring in the shop, it will be necessary to square up the points, till the ring will close enough to go into the cylinder.

In practice, this ring would be very objectionable, owing to the liability of the thin ends to break off and to wedge in between the follower and cylinder. Or, if they do not break, the side wear of the grooves and ring at its thin part would be excessive. To obviate this trouble, the rings are turned regularly eccentric, as in Fig. 5, and the ends eased off with a file, on each side of the joint, till they fit the cylinder. After fitting a number of rings in this way, one of the boys suggested to do the easing act in the lathe, by shifting the casting in the chuck, and taking a light cut off the thin part, as shown in the line *C C*, after the rings had been bored and turned. This method very materially lessened the amount of filing required to make the rings fit, and in some cases was good enough, without touching with a file, a few rubs through the cylinder being all they needed. In order to secure uniform groove wear, rings of this kind are now usually recessed on each side, as shown in the cross section at the bottom of the ring in Fig. 5.



Types of Cast Iron Snap Rings.

I found that for pistons, say 15 inches and under, the eccentric type of ring does not give enough groove surface to insure the best results, especially if the engine runs at a high rotative speed. In larger engines, after the piston is worn down, the same fault is found. Take our 20-inch piston, for example, which we will suppose has worn till it is ¼ inch smaller than the cylinder. Now, if the piston rides on the bottom of the cylinder the packing ring will only have ⅛ inch of a hold in the groove, and when the ring wears ⅛ inch, something is going to happen. If the rings are made as in Fig. 2, and doweled to the piston, so that their joints are kept near the bottom of the cylinder, the ring contact with the piston is nearly uniform and the packing O. K. More groove area would of course be better, and I decided to make a ring having a uniform cross section, which should have as many of the eccentric ring's virtues and as few of its faults as possible. This is accomplished by making a ring that is initially distorted, as in Fig. 6. The theory of this method is, that if a ring of uniform cross section, the diameter of the cylinder, is cut through at one side, and then expanded by internal forces, until it is open at the joint one per cent. of its circumference, it then presents a shape to make others by.

I have made these rings, by first making a pattern ring as just described, and then having rings cast from it, the castings being finished in a special grinding machine. Not enough advantage was found in their use to justify a claim that they filled a long-felt want, although they fit a round cylinder to perfection. Round rings of uniform section that are "flattened" at the joint, as in Fig. 5, when put into service, immediately adjust themselves to their surroundings; so that when worn out they still have a uniform thickness, or at least, as nearly so as when new, showing an equal amount of wear on all parts of their circumference.

New rings, proportioned as above, have a pressure against the cylinder of about five pounds per square inch. We can imagine how insignificant a little lack of uniform spring pressure will be when we consider that the ring is subject to an internal steam pressure of a hundred pounds or more to the square inch, to set it out to the cylinder. Even if a ring touches the cylinder only in spots at the start, it will soon accommodate itself to it. Suppose that to illustrate this point we take a round ring 20¼ inches diameter, cut it, snap it into its groove in the piston, and then put the piston into the cylinder. We now find that we can slip a steel ribbon between the ring and the cylinder, say an eighth of their circumference on either side of the joint of the ring. When steam is admitted to this piston, some of it leaks past the ring, and some of it flows under it. It is only reasonable to suppose that as there is no outlet to the groove there will be a greater pressure on the inside than on the outside of the ring; hence it springs out to the cylinder and stops the leak, and after a while it gets worn to fit, and stays out without steam pressure. Of course this way of fitting packing rings to the cylinder is not recommended.

It has been, and may be yet, the practice on some railroads to turn their snap rings the size of the cylinders, then to saw a diagonal joint, and force them over the flanges of the piston into their grooves in the usual manner. The rings are bent enough by spreading them till they will go over the flange, to give them considerable spring, when closed again in the cylinder. I do not believe that this method of using snap rings is to be commended, unless a stiff steel wire spring is put in the groove under them, which prolongs the life of a soft ring having but little elasticity of its own.

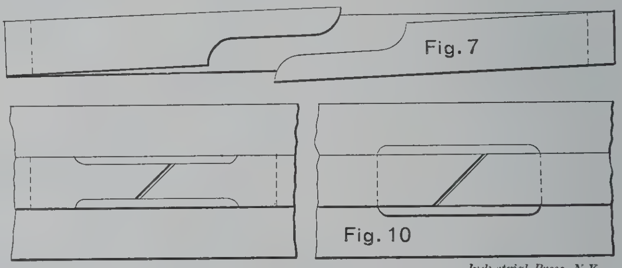
So far, only the diametrical shapes and proportions of snap rings have been briefly mentioned. We now consider their axial dimensions, or width. It is plain that a ring must be wide enough to allow some travel over the counterbore, without danger of springing out into it, if there is a slight change in the length of the rods, or variation in the position of the main shaft, or other like causes. The width required to prevent leakage will in most cases be exceeded by these practical limits. To make a piston steam-tight, it ought not to require a wider ring for a 40-inch cylinder than one 5 inches in diameter, provided the surfaces of the ring and the cylinder and other conditions are the same in each case. In practice, I believe that rings for cylinders between 30 and 15 inches in diameter, are usually made from ¾ to 1 inch wide. There is no single dimension of a detail of an engine where authorities are likely to be further apart, than on the width of packing rings. Unwin gives

$$w = d\,.014 + .08$$

Whitham's formula is

$$w = d\,.15.$$

In both formulas *d* is the diameter of the cylinder, and *w* the width of the ring. Unwin makes a 20-inch ring ⅜ inch wide, Whitham, 3 inches. If cylinder wear and lubrication are proportional to the width of packing rings, then ten of Unwin's equals one of Whitham's. It is to be hoped that authors of works on the steam engine will get together and agree on some of the small, but very important, details.



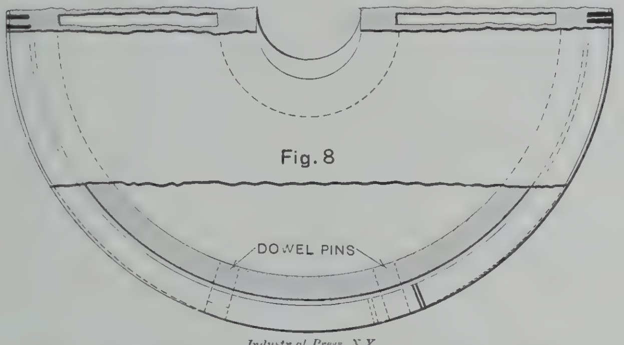
Ring with Side Twist and Ring with Joint Covers.

The ring shown in Fig. 7 is copied from Unwin, but may be found in other like works. While Unwin shows the illustration, he treats it with "a loud silence," when it comes to description. The object in giving the ring a side twist is no doubt to prevent its hammering in the groove, a condition "devoutly to be wished;" but we must remember that a packing ring to be a success in keeping the live and exhaust steam on opposite sides of the piston, must have one edge in contact with the piston, and its circumference with that of the cylinder. If a ring lies in its groove on the "bias" it is easy to see that steam can get into the groove on one side of the ring, and out at the other. Besides, a ring must be active in its groove, or it will soon get stuck fast with burned oil and then it is useless.

In horizontal engines, there can be no leak at the joint of the ring, if it is doweled to the piston near the bottom of the cylinder, for then the flange covers the joint perfectly, as shown in Fig. 8. In two-ring pistons the joints should be staggered, one on each side of a vertical center line through the piston. So far as leakage is concerned, there is no necessity of the piston being packed except where it does not touch the cylinder. I remember, when we were short on rings, sending an engine out with only a part of one ring, in the left-hand piston. The piece was long enough to pack the exposed part of the piston, and was kept in that position, by a dowel pin at each end. The engine went out, and the engineer did not know that anything unusual had happened to his engine until several months later, when his engine was in for other repairs, and the left-hand piston was examined. When the cylinder head was taken off, the brake was set and steam admitted to the back end of the cylinder. The boys said the piston was "bottle-tight," but that the cylinder was marked along the travel of the ends of the broken ring. Of course a new set of packing was put in.

This incident was the basis of a great deal of speculation aiming at minimum and uniform cylinder wear. I will not narrate the many schemes that were suggested, but show the result in Fig. 9, which does not appear to admit of further modifications, till after-use shall develop such as are necessary.

The chief objection to using steel pistons is that cast steel and cast iron do not always work well together. For instance a steel shaft will run on a cast-iron box as well as on almost anything else, for a variety of purposes; but I do not think it would be good practice to run a cast-iron shaft on a steel box under any conditions; nor a steel piston on a cast-iron cylinder. The advantages of steel pistons do not need to be enumerated further than to say that the lighter the piston the less the cylinder wear, other things, of course, being equal. Hence our design is for a steel head, but so constructed that nothing but cast-iron surfaces shall touch the cylinder.



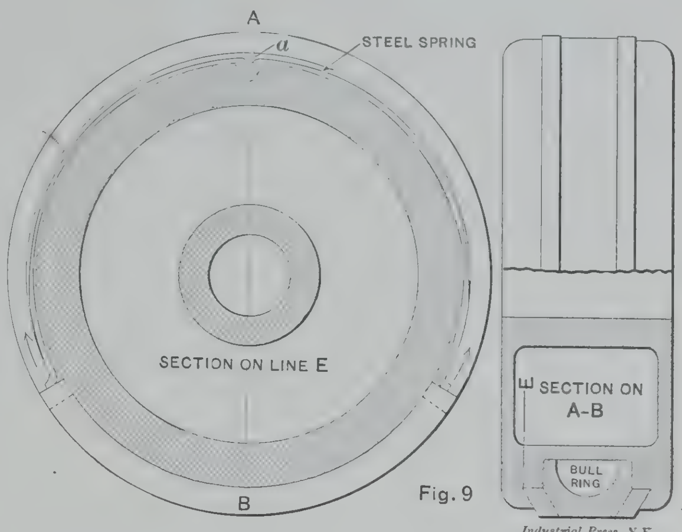
Industrial Press, N.Y.

Fig. 8. Ring Doweled to Piston so that Joint comes at Bottom.

Fig. 9 shows a skeleton bull ring, well ribbed, cut in sections, and forced into a groove in the steel piston. The outside of this ring is beveled off to correspond with packing rings whose cross sections are, say, a 30- and 60-degree parallelogram. The packing rings are made in two sections; the top one is 240 degrees long, and the bottom 120. The bottom sections are not made from the same ring as the top, but are made deeper and wider, so as not only to fill the groove clear to the bottom, but also wide enough to be forced into it. To all intents and purposes, they are a part of the bull ring. The top sections, with the exception of the shape of their cross section, are proportioned about the same as snap rings. A flat steel spring, crimped at the top, to fit into a hole in the piston, has a hook at each end, and the action of the spring is to lift and also to expand the top section, while the weight of the piston keeps the bottom section set out to the cylinder. The flanges of the piston are cut away on the bottom to allow for a reasonable amount of wear of bull ring before the flanges can touch the cylinder.

Of course, steam will get under these rings, just the same as though they had a square cross section, but it will not set them out to the cylinder with the same force; for, assuming the joint or contact between packing and bull ring to be steam-tight, the packing ring is steam-balanced in radial directions. Some pressure is necessary between the ring and cylinder, to keep the ring from leaking, but I think it should be constant for all steam pressures, and not vary with that pressure. There can be no doubt cylinders would wear parallel if the pressure was constant; as it is, the wear is most where the pressure is greatest.

Mr. Ramsbottom, an English engineer and inventor of what is called to-day a "snap ring," found them to be tight against 100 pounds steam pressure, with a radial pressure of but 3½ pounds per square inch. With present high pressures, say we use a five-pound tension for rings, then if they are steam-balanced, we shall have but about five per cent. of the ring-friction and ring-wear that we have now. While the direct saving in power would be small, it would simplify the problem of lubrication very materially, and very appreciably lengthen the interval between cylinder borings and bushings. Renewals of packing ring and piston adjustments would also be less frequent. I shall have to plead guilty to discussing this same topic in my last letter under this heading, and as an apology will say that the subject does not seem to be exhausted.



Industrial Press, N.Y.

Fig. 9. Piston having Skeleton Bull Ring and Beveled Packing Rings.

Fig. 10 shows two of the most popular joint covers for packing rings. In one, the edges of the ring are reduced to receive a cover-piece; in the other, the groove is milled out to let it in. In both, the cover-piece is held out by a spring, usually a flat one riveted to it. In the former the ring may revolve in the groove, while in the latter it must be doweled to the piston.

* * *

Probably there is no more severe test of a man's qualities than to subject him to entirely changed conditions from what his life training has used him to. This applies as forcefully in the machine shop as elsewhere. Machinists are constantly being called on to change their methods, to adapt themselves to new machines and to adapt old machines to new work, etc. The quickness of the American mechanic to do these things is almost proverbial and it is one of the secrets of our mechanical success. The comparatively recent advent of the high-speed tool steels has worked practically a revolution in many American shops in the matter of output, and it has also made necessary a complete re-designing of the line of machine tools built by most makers. Our English contemporaries complain of the stubbornness of their machinists in adapting themselves to the changed conditions since the advent of the Taylor-White process. One of them seriously states an ignorant laborer brought in to attend a heavy lathe will soon secure double, treble or even quadruple the output of the experienced man who cannot or will not grasp the significance of the new order of things. The laborer is not afraid of cutting speeds of 60 or even of 100 feet per minute because he knows no different. While there may be a grain of truth in these caustic remarks, as far as it applies to English shops, we are pleased to note that in American shops there is little trouble in getting lathes and other machine tools worked to their full capacity when using high-speed steels, especially where the manufacturer is willing to pay for the additional work. Perhaps "there's the rub" on the other side for it has become a pretty well-defined English policy to allow a man to earn only about so much regardless of what his output is.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

One of the striking novelties proposed for the St. Louis Exposition, is an imitation $1,000,000,000 gold coin, that is, one in size that if made of solid gold, would be worth the sum stated. Taking a $20 gold coin as the standard of measurement, the imitation $1,000,000,000 coin will be 40 feet in diameter and 30 inches thick.

The *Mechanical Engineer* states that what is probably the largest steam boiler ever built, is that supplied by Normand & Co. for a torpedo boat built for the French Government. The boiler is of the water-tube type and supplied steam for 3,550 indicated horse power. Allowing a steam consumption of only 12½ pounds per I. H. P., the boiler had to evaporate 746 pounds of water per minute. "That's bilin' water purty fast."

In a paper read by P. M. Lincoln before the American Institute of Electrical Engineers, at a recent meeting, reference was made to the extraordinary sensitiveness of the ordinary telephone receiver which makes it one of the best detectors of electrical disturbances known, if not the best. An authority is quoted who says that the energy used in an ordinary 16-candle power incandescent lamp is sufficient to produce an audible sound in 30,000,000,000 receivers!

In the April *World's Work* the writer of an article on conveniences in the modern model American residence, mentions the growing use of acetylene gas apparatus for lighting isolated homes, far removed from municipal gas plants, and in connection says that the spent carbide which has always been thrown away, has recently been discovered to be a valuable fuel. Mixed with coal clinkers it burns with intense heat in an ordinary house furnace. So it appears that another "waste" product can be profitably utilized.

An oil fire is one that is practically impossible to extinguish when it is extended over an area of much size. Water is worse than useless for extinguishing an oil fire as it simply spreads it and makes it worse. At the recent (April 15) $1,000,000 fire on the famous Spindle Top in the Beaumont oil region of Texas, it was again demonstrated that steam is an invaluable agent for extinguishing oil fires. The steam from a stationary boiler was turned on a burning ditch of oil in which the flames were several feet high with the result that they were completely extinguished and prevented from spreading into a valuable section of the field that otherwise would have been burned over.

The United States commercial agent at Eibenstock, Germany (Ernest L. Harris), calls attention in a recent consular report to a German device for automatically drawing off condensation from steam engine cylinders without wasting steam. The device appears to consist essentially of a pair of poppet valves mounted in a suitable case which is inserted in the middle of a pipe communicating with both ends of the cylinder. The valves are alternately opened and closed by a tappet worked by the valve motion, and the water drains out during the exhaust strokes. The discharge pipe of the apparatus is connected to the condenser in the case of condensing engines. It is manufactured by Schneider & Helmecke, Magdeburg, Germany, and its success in that country is said to have been marked.

An apparently impossible result may sometimes be attained by an inversion of the ordinary process. *Stahl und Eisen* in a recent issue describes a case in point. The refractory lining of a blast furnace of the Metz works at Eschsurl Alzette, Lorraine, was nearly destroyed after eight years' use. When this condition was reached in February, 1899, the market price of iron was so high and the demand so great, that serious loss would have been entailed on the whole plant by shutting down to re-line the furnace. A new refractory lining of firebrick was built outside the red brick exterior, brackets having been applied to support the new wall. The brackets were applied in 1899, but the wall was not built until 1900 when gas was escaping from cracks in the old wall. Although the interior volume was increased by nearly 5,100 cubic feet from the original size it is claimed that the operation is fairly satisfactory.

John Brisben Walker made an address recently before the New York Rapid Transit Commission in which he advocated a complete revolution in present methods of city transportation, employing automobiles in place of street, elevated and sub-service cars, or rather in conjunction with them. Mr. Walker argued that but comparatively few passengers could be carried in each vehicle (all of which would have seats) so that it became to all intents and purposes a through train making the trip in quick time and with most passengers, a minimum of trouble and annoyance. Not being confined to streets with rails the automobile system would be free to extend to any and every street, and he believes that the system can most successfully compete in the matter of cost and convenience with the present ones. Whether this idea will ever be realized to the extent advocated, or not, time will only reveal, but the indications are that the automobile will soon displace the horse-drawn cab, because of its greater cheapness and speed, which make it a more reliable and agreeable means of getting about, to those who can afford to travel more expensively than by street cars.

Consul Frank H. Mason of Berlin reports that that city has one of the most satisfactory electric traction systems to be found in any city in the world. The elevated and underground electric railway, constructed by Siemens & Halske, has been in operation for a year and has proved a remarkable success. It has very low rates for fares, and yet the profits have exceeded the estimated profits for the first year of operation by 80 per cent. It carries passengers a distance of three miles in 10 minutes for from 2½ to 3¾ cents, according to the class of car. It is probable that this system will be very much extended to other points of the city and experiments are under way looking to a transformation of the steam railroad system between Berlin and distant points, establishing more intimate interurban communication. It is proposed to substitute for the three or four long express trains which run daily between these cities hourly three-car trains capable of carrying about 100 passengers and baggage, at a speed of 75 miles an hour. Prizes have been offered by the National Society of Mechanical Engineers for the best designed locomotive and cars for this service and tests that are to be held in the near future will be awaited with considerable interest.

The Transandine Railway, which is now nearing completion, is a most important South American engineering enterprise, not only because of the enormous physical difficulties overcome in its construction, but vastly more because of the stimulating effect it will have on the commercial relations of the two countries thus brought into intimate contact, notwithstanding the Andean barrier between them. The new railway, which is nearly 150 miles long, forms the connecting link between the trunk lines of Argentine Republic and the state railways of Chile and gives through railway communication between the eastern seaport, Buenos Ayres, and the western seaport, Valparaiso. It completes the first railway line to cross the continent of South America. The terminals of the connecting link are Mendoza (2,800 feet) and Los Andes (3,000 feet), and the highest point in the line is 10,450 feet above sea level. At the summit the line passes through a tunnel 12,800 feet long. This, however, is not the highest point reached by commercial railways, the Ferro Carril Central del Peru, in Peru, having that distinction. Where this line crosses the Andes it is 15,665 feet above sea level—the highest point reached by any railroad in the world.

BEAUMONT OIL WELLS.

The oil wells in the Beaumont region are not drilled with a jump drill as they are almost universally in other regions where the oil strata is only reached by penetrating rock. In the Texas fields the oil strata lies beneath earth and quicksand, and the ordinary method of drilling cannot be employed. The first wells in this locality were abandoned at shallow depths because the quicksands filled the bore faster than it could be bailed out. The prospector, A. F. Lucas, who discovered oil at Beaumont was forced to abandon his first well from this cause, but he later tried another method by which the first famous gusher was "brought in." In this method an eight or ten-inch casing pipe is sunk into the ground by washing the earth away from the bottom and forcing it up through the pipe. The earth is loosened by a flat drill attached to the bottom of an inner four-inch pipe by straps so that the opening is clear. Through the interior four-inch pipe, water is forced downward and at the same time the drill is revolved. The water and earth rise in the outer pipe, which is forced downward at intervals as the hole descends. The four-inch pipe is turned by suitable gearing attached to the upper end and connection is made to a steam pump by means of a cap and stuffing-box which permit the pipe to turn freely, yet confine the water. The first Lucas well struck oil January 10, 1901, at a depth of 1,120 feet. Prof. O'Neill, in *Sunset*, says that the flow of oil, water and gas threw out 700 feet of four-inch pipe weighing about six tons, carrying away part of the derrick, and the spray and stones went 300 feet upward in the air. The flow was estimated at 75,000 barrels a day, and in a short time it covered an area of nearly 100 acres, being confined by levees. No wonder people went crazy with the speculative fever. Everybody began to drill wells and the derricks on Spindle Top were soon so close that they actually touched one another in some places. So much oil was thrown on the market that the price went down to two and three cents and even to one cent a barrel at the wells.

THE UNION ENGINEERING BUILDING.

In the early part of May the announcement was made that Andrew Carnegie had offered to give $1,000,000 to the four great engineering societies of America and the Engineers' Club of New York City, for the erection of a union building in New York to be the common home of these five organizations. The plan of having a great engineering headquarters in this city, where the engineering interests of both the city and the country at large should be centered, has been long talked about as a possibility, though hardly as a probability, because of the enormous expense of such an undertaking. With the gift of Andrew Carnegie, however, the possibility changes to almost a certainty, depending only upon the favorable action of the various societies involved.

It is worthy of note that this generous action by Mr. Carnegie was entirely spontaneous, coming as the direct result of a meeting of the American Institute of Electrical Engineers which he attended and at which addresses were made urging a unification of the branches of the engineering profession in so far as it should be possible. To carry out the project, pending the acceptance of the gift, options have been secured on property immediately adjoining the site of the new New York public library building, which if finally used, would bring the two libraries in adjoining buildings—an arrangement much to be desired. Mr. Carnegie proposed that the organizations pay for the land for the building, and he estimated that with what they were now subscribing for rent they would be able to care for a building such as he would be glad to provide, and so the sum comprising his gift is to be devoted solely to constructing the building itself. Committees have been appointed by the societies interested, who have plans under advisement for carrying through the project in all its details. The only hitch in the proceedings that is likely to occur may come in the action to be taken by the American Society of Civil Engineers, which is the strongest of the engineering societies and owns a handsome new building of its own, entirely adequate to its needs for many years to come. Anticipating a possible disinclination of the members of this society to abandon its present home in favor of the union headquarters, the *Engineering News* has sent out letters to forty leading men of the profession, asking an expression of opinion upon the advisability of the move. The replies were very gratifying as showing a strong sentiment in favor of the Carnegie plan, and it seems fair to presume that the opinions expressed in these letters voice with a fair degree of accuracy the views of a majority of the members of the society.

A. S. M. E. COMMITTEE REPORT ON THE METRIC SYSTEM.

The report of the committee appointed at the last regular meeting of the American Society of Mechanical Engineers to investigate the subject of the metric system has been issued and distributed to the members. The appointment of this committee was the result of Mr. Halsey's paper upon the metric system last winter, which led to a more extended discussion than any other paper ever presented before the society. A committee had previously been appointed to report upon the metric system, but as it was composed entirely of men with preconceived ideas against the system and their report was accordingly unfavorable to the system, the second committee was named, having two members, Mr. Christie and Mr. Miller, for the metric system, and two members, Mr. Kent and Mr. Bond, against the system, with the view of obtaining a fair and impartial review of the question.

As a matter of course the four members of the committee could not get together on common ground and present a common report, as there was not a majority either for or against. The bulk of the report is therefore made up, first, of the "pro-metric" argument by the two metric members, and the "anti-metric" reply by the anti-metric members, and second by an anti-metric argument and pro-metric reply. After these are several pages of notes, comments, extracts from the press, and various data bearing upon the subject in general. This pamphlet has 72 pages, and Mr. Halsey's paper and discussion, which accompany the report of the committee, make up a pamphlet of 231 pages. These two present a mass of matter upon the metric system, pro and con, such as it is safe to say was never before gathered together, and may never be again. From the various pages one can find arguments to prove anything he wants to about the question, exactly adapted to his own ideas and notion of things. The papers do not prove anything one way or the other; they probably will not convince anybody one way or the other; but nevertheless are very good documents to have on file. The beginning of the report of the committee of four is composed of a few paragraphs that all the members subscribe to and represent probably the only main points upon which they are generally agreed, and possibly upon which any similar committee could agree. They are as follows:

1. Legislation designed to compel the exclusive use of the metric system is not desirable.

2. We believe that such legislation could not be enforced in any event so far as transactions between private individuals are concerned.

3. The general government has the power to specify the system to be used in its own work and business and can require that work done for it by contractors shall conform to any specified measurements or weights.

4. The government cannot compel anyone to bid upon its specifications.

5. Recognizing the well settled fact that the consumer does and must pay all necessary costs of production, we believe that if the government specifies such dimensions as will materially increase costs of production, the government and not the bidder will have to pay such increased costs, it being self-evident that a bidder, not compelled to bid, will not bid except at a price which will afford him a profit.

6. The bill now before Congress is intended to make the use of the metric system compulsory in the several departments of the government, but it cannot make it compulsory in private transactions.

7. We believe there is no force in that class of arguments which consists in taking integral dimensions in one system, translating them into equivalent and therefore fractional dimensions in the other system and then making comparisons. Such arguments can be made as strong for the one system as for the other.

GAS PIPE LINE.

L'Echo des Mines et de la Metallurgie, March 2, 1903, p. 247.

It is proposed to erect gas houses at the mines and produce gas that is to be taken to Paris under a high pressure through pipe lines to be supplied for heating, lighting, power and electric generation purposes. It is thought that this can be done and the delivery made for .05 franc per cubic meter, which is equivalent to about 28½ cents per 1,000 cubic feet. In regard to the liquefaction of the hydrocarbons by pressure or cold either singly or combined, it is argued that the temperature of distillation has a considerable influence upon the fixation of the same. Gas made at a low temperature precipitates more benzol than gas produced at a high one. Oil gas is richer in hydrocarbon than the richest coal gas, and yet this is subjected to exceedingly high pressures for transportation. Means are suggested for draining the pipes, and the ammoniacal liquor so obtained is to be used directly for fertilizing purposes instead of the salts, as at present.—G. L. F.

LOCOMOTIVE MAGNETIC TRACTION INCREASER.

Railway Age, April 10, 1903, p. 705.

The use of magnetism to increase the adhesion of locomotives has been frequently suggested, and experiments made on a small scale seem to indicate that a great increase of adhesive power could be obtained in this manner. The article under review was called forth by a magnetic traction increaser that is being exploited in Chicago and for which apparently most extravagant claims are set forth by the company, who say that an increase of adhesive power from 200 to 300 per cent. is possible. It is shown, however, that according to well-established laws of magnetism, the magnetic density of the magnets could not practically be made such as to increase the effective load on the drivers on a 100-pound rail more than 1,500 pounds, allowing an area of contact of ¾ square inch. This is, of course, an addition of only about 10 per cent. of the average weight on the drivers of modern locomotives. While the small-sized models do undoubtedly show a wonderful increase in the adhesive power, the increase is not in proportion with a full-sized locomotive. In fact, the figures given above are liberal and it is quite doubtful if they could be reached in practical application.

THE BROADENING EFFECT OF INTERCOURSE.

Youth's Companion, May 21, 1903.

For many hundred years manufacturers and craftsmen of various kinds guarded the secrets of their trades as if success depended upon keeping competitors ignorant of their methods. Monopoly of trade was sought through monopoly of knowledge. The day of the trade secret has passed, although there are some survivals where manufacturers are not content with the short monopoly that the patent system gives them. In its place has dawned the day of trade conferences, in which men discuss processes of manufacture and methods of sale. Men engaged in distinctively intellectual occupations have long recognized the necessity of getting together to compare notes and to talk over the things in which they had a common interest. The conferences of ministers and medical associations are good examples of the practice. Although there have been boards of trade and chambers of commerce for years, the trade conference in its present form is a recent product. It is the result of the broader education of the world which has made men dissatisfied until they had learned all there is to know about the thing in which they are interested, whether it be the manufacture of locomotives, the raising of beets, or the origin of Greek roots.

FINISHED MACHINE WORK.

Mechanical World. (Manchester) March 13, 1903. p. 121.

After considerations of price and utility, buyers of machinery are regardful of appearance in the articles they purchase. Other things being equal, the machine with most bright work has decidedly the better chance of being sold, and not infrequently bright parts and a high finish will effect a sale in spite of a high price. This fondness for polished work is, in the opinion of some engineers, a mere fad—a waste of money on the part of the buyer; and they maintain that all the polished work in the world will not increase the efficiency of a machine. Yet in spite of this we venture to say that the man who chooses the bright machine generally makes the better bargain, taking full account of the increased price he has paid. Probably he buys the bright tool simply to please his artistic sense, but there are advantages in bright work beyond a mere pleasing appearance. In the first place, the manufacturer is compelled to select good materials for those parts which must take a high polish. Inferior metal would not pay, because of the difficulty of imparting a high finish to it. Another advantage of bright work is that it often shows flaws in the material which would have remained concealed in a black job. The buyer of a bright job has therefore some guarantee that those parts highly finished are of good material. There is yet another consideration which is all in favor of the bright finish. The owner can see at a glance whether the machine is properly attended to, and whether it receives rough usage at any time. In overhauling the machine the attendant is bound to use the bright parts with care. He dare not strike any of the bright parts with a naked hammer, nor dare he use bright nuts with violence, as the rough treatment would be detected. Hence for his own sake he will endeavor to keep all parts easy, so that when there is overhauling to be done there will be no necessity for rough usage in getting the parts asunder.

REGARDING THE FIRST STEEL MADE IN AMERICA.

Iron and Machinery World, April 25, 1903, p. 32.

W. M. Atherton, of Chicago, Ill., while at Afton, N. Y., a few weeks ago, discovered an old document of considerable historic interest, being a contract made by his grandfather, Cornelius Atherton in 1772 to instruct John and Ezra Reed in the art of making steel. The subject of the contract was of great importance to the colonists at the time it was written, as they were entirely dependent upon the mother country and Germany for all the steel they used, and even the German steel could reach them only through a British port and British bottoms. How Cornelius Atherton became possessed of the secret of making steel is not known; that he was the first manufacturer in the United States is a fact well authenticated. The Reeds were merchants and carried on the Dover Iron Works, adjoining the town of Amenia. The old steel works were built by Cornelius Atherton under this contract.

Cornelius Atherton was born in Cambridge, Mass., 1736, and came to Amenia in 1763, where he soon became the manager of the Dover Iron Works. In 1769 he returned to Boston, and in partnership with John and Samuel Adams and John Hancock commenced the manufacture of firearms and cutlery. Here he made his first successful experiment in steel. At the end of six months the works were burned by an incendiary, supposed to be the British soldiers then quartered in Boston. In 1770 he returned to Amenia and built the steel works in the latter part of 1772, and in 1773 went to Plymouth, Pa. He settled on the land upon which the Shupp's mill was afterward built. Here he made steel in small quantities, and manufactured blacksmiths' anvils and made rifles for the hunters. During his residence there he began to use anthracite coal in his shop. In 1773 he went to Florida, Orange Co., N. Y., where he remained until 1783, when he returned to Taylorville, Pa. During his residence there he constructed the old Wright forge, also the forge of E. & B. Slocum at Slocum Hollo, now called Scranton, Pa. At this place he made steel in small quantities. He died at South Bainbridge, N. Y. (now Afton), in 1809.

PETROLEUM LUBRICATING OILS.

Abstract from Paper read by W. F. Parrish, Jr., before the New England Railway Club, April 30, 1903.

The author states that the birthday of the petroleum business of the world was August 28, 1859, when Col. E. L. Drake struck a 25-barrel oil well on Oil Creek near Titusville, Pa., at a depth of 169½ feet, boring the hole after methods suggested by Bissell. There are three general methods of distilling petroleum which are followed according to whether the desired product is burning oil or lubricating oil:

1. Destructive distillation, or "cracking." The crude oil is

placed in a still with a large dome and heated to a certain temperature, when the fires are slacked and the distilling allowed to proceed slowly. The distillate passing off condenses on the cooler dome, and finally falling back into the hotter liquid below is further broken up. This is termed "cracking," and is the general method used in manufacturing burning oils. A large amount of product can be obtained in this way. The residuum is used for the manufacture of lubricating oils, etc. This residuum, if simply distilled and purified by chemical treatment after the removal of the paraffine, is what is known as "paraffine oil" in this country.

2. Distillation by the introduction of superheated steam. This is done to prevent the overheating of the oil.

3. Distillation in a vacuum. In this process a partial vacuum in the still is maintained by a pump, and a higher comparative temperature may be used without danger of destroying any of the parts of the crude.

The last two processes are the ones used by the manufacturer who regards the lubricating oil as of first importance.

The author then goes on to show the prime importance of purchasing lubricating oils with some knowledge of their manufacture. He states that a change of the set of oils used in textile mills very often results in the saving of from 5 to 15 per cent. of the power expended. Seven per cent. reduction in power in the average textile mill will equal the price paid for the better oil.

Properly made engine oil can be used over and over again indefinitely if filtered and settled. Automatic oiling systems are advocated for all power plants, using pumps and gravity feed. A lighter oil can be used and fed on the bearings in a stream, which is the most effective method of lubrication known.

INDEPENDENT AIR-PUMPS AND CONDENSERS.

Electrical Review (London), May 8, 1903. p. 803.

In his usual clear and forceful manner, Mr. W. H. Booth points out a practical disadvantage of the independent condensing set in stationary practice that may be unsuspected by many power plant engineers. Of course when an independent air-pump is employed, its speed may be regulated exactly to what is necessary. If the vacuum falls the pump may be speeded up, and if it is too high the speed of the air-pump may be reduced. But this flexibility of action is the chief disadvantage of the independently-driven condensing set. Young engineers are exceedingly perfunctory in their behavior towards a condensing plant. They look upon the air-pump as a pump for air, and take good care to supply plenty of air for it to remove. The air-pump is certainly intended to remove air, but it is only intended to remove a certain irreducible minimum and with surface condensation this minimum should, obviously, be very small indeed. As a fact, it is usually very large, and when an engine is shut down and all valves and cocks about it are closed, the vacuum gage on the condenser falls rapidly to zero, whereas it should not fall below 24 inches in the course of an hour. This is a practical possibility. In theory it should never disappear, but it is excellent and exceptional practice which can show a 24-inch "vacuum" after an hour's stoppage. If anything like this can be shown, the air-pump is not being saddled with much unnecessary work, and should easily maintain a working vacuum of 26 to 28 inches. If, however, the vacuum does not hold up well in the stopped engine, it may be bad to run the air-pump fast enough to maintain 24 inches. Now this is what many engineers persist in doing. They have a vacuum which will not hold up well when the engine and air-pump are stopped, but they keep it up to 22 or 26 inches by driving the air-pump at an excessive speed, with great waste of power. This is where the independent air-pump appears at fault. By its means a poor vacuum is made as good as possible by furious running of the pump instead of by searching for and stopping leaks in injection and exhaust pipes, at glands and cocks, and many other weak spots in the chain. When the pump is driven off the engine, it can never be run beyond its designed speed, the vacuum drops in response to an air leakage, and cannot be improved except by stopping the air leak.

POWER FROM BLAST FURNACE GAS.

Electrical Review. April 4, 1903. p. 463.

More and more attention is being given to production of power from combustible gas, especially in motors of the internal combustion type; and to ways and means for utilizing the lean waste gases from metallurgical plants. The development of the gas engine has reached a point where it is perfectly safe for a large manufacturing establishment to use gas engines for motive power. To manufacture gas for power cheaply, gas companies have been organized in different cities to supply producer gas for fuel and power. The possibility of using lean gases economically when they are manufactured especially for the purpose, only serves to draw more earnest attention to the enormous waste of combustible gases that takes place daily in our blast furnaces. For the production of each ton of pig iron it is estimated that gas capable of generating 13,587,000 B. T. U. and weighing nearly 10,590 pounds, is produced which is now for the far greater part entirely wasted. The development of blast furnace engines has reached its highest point in Germany, which country leads all others in this respect. The majority of the gas engines in operation in Germany are over 500 H. P. and a number are as large as 1,000 and 1,200 H. P. One pound of blast furnace gas generates 1,283 B. T. U. and from 20 to 30 per cent. of this energy can be utilized. One horse power is equivalent to 2,545 B. T. U. and on a basis of 25 per cent. efficiency something less than 8 pounds of blast furnace gas will generate one horse power. The gas from a blast furnace producing only one ton of pig iron an hour, allowing a waste of 25 per cent., should, if properly utilized, produce nearly 1,100 horse power hours. This vast amount of waste power would be sufficient to operate a large power station.

The importance of this is further emphasized when we consider the industry of pig iron production in the United States. The average rate of production of pig iron amounts to nearly 1,500,000 tons per month. The gas generated by the blast furnaces for making this amount of pig iron would be sufficient to run several manufacturing plants, and incidentally produce more power for electrical purposes than Niagara. The power generated by the gas could furthermore be utilized for running the blast furnace plants, and still leave a surplus more than three times as great for other purposes. The operation of pumps and blowing engines by steam generated by coal as fuel could be replaced by electrical generators driven by gas engines.

METALLIC TUBING AND TUBE FURNITURE IN GERMANY.

Consular Reports, April 30, 1903.

The manufacture of tubes and pipes from iron, steel, copper, and other metals and alloys, although of comparatively recent date, is one of the most extensive and highly developed industries of its class in Germany. There were in operation at the close of 1900 seventy-seven manufactories of metallic tubing, some of which—as, for example, Predboeuf et Cie., the Mannesröhrenwerke, and the Röhrenindustrie, all at Düsseldorf—are large establishments with ample resources and equipped with every facility for cheap production on a large scale.

The Mannesmann process for rolling seamless tubes and the Ehrhardt system by which seamless pipes are drawn by forcing a mandrel under hydraulic pressure through a block of metal, are both German inventions which have been developed and worked with notable success in this country; while Larson's Swedish process for making steel tubes, the Murphy process, and the Robertson and Elmore patents for making copper and brass tubes are all employed here under the most advantageous circumstances.

Among the various uses to which iron, steel, and brass tubing are applied in Germany, one of the most modern and important is the manufacture of furniture—especially bedsteads, cot frames, and tables for household, hospital, and military purposes. Tubular metallic bedsteads are not only cheaper, lighter, and more easily flexible than those made of wood, but they offer no harbor for vermin and lend themselves readily and without injury to disinfection and all the processes of sanitation. For these reasons and because they are cheap, light, and serviceable, the manufacture of tubular bedsteads and other articles of furniture, which began in England and was adopted in Germany hardly a dozen years ago, now employs capital estimated at 15,000,000 marks ($3,570,000) and from 50,000 to 60,000 operatives. As the industry has developed, there has been a steady progress in the effectiveness of the machinery employed for shaping, cutting, and jointing the parts; soldered joints have given place to screw connections, detachable when desired.

Bedsteads are made either wholly of iron and steel tubing, of the same tipped and decorated with brass and nickeled mountings, or wholly of brass tubing, the latter class being, of course, the most decorative and expensive and adapted to luxurious households, hotels, and private sanitaria. When intended for hospitals, iron bedsteads are covered with a waterproof varnish, which protects them from oxidation or injury in cleaning or disinfection.

THE LJUNGSTROM CONDENSER.

Abstract from Paper read by William Cross before the British Institution of Naval Architects.

The paper describes a new form of steam engine condenser invented by F. Ljungstrom, a Swedish engineer, which is remarkable for the great efficiency of the condensing surface as compared with the ordinary surface condenser commonly used in marine service. The area of condensing surface usually allowed per indicated horse power for triple expansion engines in the merchant marine, is about 1.3 square feet. For the somewhat more economical engines of the British navy, and on account of the restricted space, the condensing surface is cut down to about 1.1 square feet per indicated horse power for the heavy powered vessels like battleships and cruisers, and to 0.75 square feet per indicated horse power in the case of torpedo boats. Small vessels fitted with condensers consisting of D-shaped copper pipes attached to the outside of the hull, have the surface still further reduced to about 0.50 square foot per indicated horse power. The Ljungstrom condenser requires only 0.27 square feet of condensing surface per indicated horse power for equal engine efficiency.

Briefly, the Ljungstrom condenser consists of a number of thin diagonally corrugated chambers or elements of brass fixed together in packets, so arranged that the corrugations mutually support one another. These packets are fixed in a rectangular casing in such a manner that the cooling water flows horizontally through the chambers, and the steam flows vertically outside the chambers, it being understood that the space through which both steam and water have to pass is limited to the depth of the corrugations. The result is that a very large number of fine streams of steam and water are compelled to travel a sinuous course in close proximity to each other, being only separated by the thin walls of the corrugated chambers. The upper part of the rectangular casing is full of steam at a pressure due to the exhaust, while the under side is open to the air pump, the two being separated by the packets of corrugated chambers. The steam therefore is constrained to pass along the corrugations in intimate contact with the cooling water, and with sufficient velocity to sweep with it all condensed water. The action is thus very different to that in a condenser of the ordinary type where the steam is admitted into a large chamber full of cooling tubes, and allowed to wander about until finally condensed, when it drops to the bottom and is drawn off by the air pump.

In large condensers the evil of the steam endeavoring to take a short cut to the suction pipe is, to a certain extent, recognized, and diaphragm plates are fitted so as to compel the steam to traverse more completely over the tubes, but even then it is certain that the circulation of steam is very defective.

SLIPPING OF LOCOMOTIVES AT HIGH SPEED.

Mechanical Engineer, May 9, 1903. p. 624.

The writer, Mr. C. E. Wolff, refers to the obvious and well-known fact that when the horizontal inertia forces in a locomotive are balanced, a vertical disturbing element is introduced which causes a variation in pressure of the driving wheels on the rails. Since these forces vary as the square of the velocity, there is clearly a limit of speed beyond which the drivers will lift clear of the rails every revolution. Consequently slipping must take place at certain points when the speed is such as to cause the adhesion of the drivers to fall below the tractive force of the locomotive. Based on this theory Mr. E. L. Hill in 1892 predicted that it would be impossible to run one of the Midland single-driver locomotives faster than 80 miles an hour, but unfortunately for his calculations the engine subsequently drew a train at 87 miles an hour. With the view of discovering the reason of the apparent contradiction of theory and fact the writer made an investigation of the subject with results that are not without interest.

Plotting the tractive and adhesion curves he found that the curve for adhesion fell below the tractive effort curve, it is true, at the higher speeds, but only for a period of time of about 1-18 second for the locomotive investigated by the author. Hence before the driving wheels have had time to acquire any great velocity the adhesion is once more greater than the tractive force and no slipping takes place until the crank arrives at the same point in the next revolution.

In order to test this matter the results of Galton and Westinghouse's experiments on the coefficient of friction at different velocities of slipping were made use of. These results showed that the value of the coefficient of adhesion is very accurately given by the expression $\frac{4}{V + 20}$ where V is the velocity of slipping in feet per second. The moment of inertia of the driving wheels and axle was known, having been calculated for some previous tests in connection with the same engine. From these data the accelerations and velocities of slip were calculated for successive intervals of 1-500th of a second, the coefficient of adhesion for any interval being obtained from the velocity of slipping at its commencement. No appreciable error is introduced by this method of calculation, as the intervals of time were so short that the increase of velocity during any one interval was very small indeed. As a matter of fact, the maximum increase of velocity never exceeded 1 foot per second.

The result shows that the total slip to be expected under the conditions of the test at 35 miles per hour is about 86 inches per mile, or ⅜ inch per revolution, while in the test at 65 miles per hour the corresponding figures are 18 inches per mile, or less than 1-10 inch per revolution. It would appear that the adhesion curve may fall very considerably below the curve of tractive force during part of a revolution without continuous slipping taking place. It is also worthy of note that the smaller the diameter of the driving wheels the greater will be the variation in the adhesion. Hence it is possible for the percentage slip to be much greater in the case of a coupled engine with small wheels than in the case of a single engine having large driving wheels without the slip ever becoming continuous. As this slip represents a pure waste of energy, this fact may serve to partially explain the superior economy of engines having large driving wheels.

MANUFACTURE OF COLD ROLLED SHAFTING.

Modern Machinery, May, 1903. p. 148.

Open-hearth steel of a low percentage of carbon, is the material most generally used for making cold rolled shafting, but it must be most carefully made and perfectly homogeneous throughout, otherwise the hard spots will cause the shaft to "cockle" in the planishing process. After being heated to a good yellow heat the ingot is passed through an ordinary pair of reducing rolls until it is rolled to about one-half inch larger than the finish diameter, the allowance, of course, depending on the size of the shaft.

The next pair of rolls that the bar is passed to on its journey (for this is a continuous operation and the ingot commences at one end of the mill and never stops until it is ready to be planished at the other end) is of an entirely different kind than the ordinary rolls, being a pair of horizontal pass rolls with a pair of vertical rolls just behind each gully and of a slightly smaller diameter than the preceding one. As it is necessary to impart a rotary motion to the bar, as it passes through these rolls for the purpose of leaving no seam on the bar, one of the vertical rolls is slightly skewed relatively to its mate, thus bringing their centers out of line and imparting the rotary motion that is so essential to the high finish given to the bar at the end of its journey. The shaft is passed through these rolls until it is reduced to about 1-64 inch of the finished size and when cold enough to handle is taken to the planishing lathe for the final operation.

This operation is only resorted to, to finish the highest class article that is turned out, as the horizontal and vertical rolls can be adjusted to finish the bar very closely; but to get a bar that is absolutely straight, and of the right size, the planishing lathe must be resorted to. This lathe is especially built for the purpose and has a pair of hardened steel rollers set in a frame on the carriage. These rollers must be made very accurate and polished to the highest degree, otherwise the bar will show each inaccuracy or flaw as the rollers pass over it. The size most generally used is about 4 inches diameter by 2½ inches face, nicely rounded off and one roller set ½ inch ahead of its mate. The bar is placed in the lathe in the condition it came from the mill and the rollers are forced together by a hardened steel gage until the required size is obtained. The feed is thrown in and the rollers begin the journey and put the size and finish on the bar that is almost impossible to obtain with the turning lathe. The travel of the rollers is very rapid as the lathe is run at high speed and the bar is soon finished so far as this part is concerned. After being taken from the lathe, the bar has a beautiful smooth finished surface and will be found as straight as it is possible to make it; and if the condition of the tools used is as it should be, the bar, after passing to the cold saw to be sawed to length, is ready to be made part of any engine or machine that requires accuracy of finish and beauty of material entering into its component parts.

As this high grade product commands a good price on the market and the uses for it are becoming more general each year, no expense or care is spared in the machinery used in its production. Large sums are spent to produce rolls that will do the work in the most efficient manner and great care must be exercised in their adjustment to manufacture a product that will compete with the best lathe work obtainable. Water is used as a polishing medium on horizontal and vertical rolls, and the best result is obtained with a fine spray as a heavy stream cools the bar too quickly. With the proper mixing of the metal in the first process the bar when finished needs no annealing, but as this is not always done, annealing is sometimes required to have the bar soft enough to work properly. Especially so when the proportion of carbon is greater than it should be; but as the art of making open hearth steel has become a science, one might say the product from old established firms is very uniform and gives the best of satisfaction to the user of this modern and splendid product of the rolling mill.

HIGH-SPEED TOOL STEELS.

Abstract from Paper read by William Lodge before a recent meeting of the Cincinnati Machine Tool Manufacturers and Published in the Iron Trade Review.

In using high speed steels on cast iron we are obliged to drop down to a speed of about 45 feet per minute in order to get the best results; and while a good deal of cast iron may be turned at 70 feet per minute, if this feed is given to the workman he becomes confused as soon as he strikes a casting a little bit harder than will admit of this speed. I find in general that the ordinary workman does not reason cause and effect sufficiently well to know that the fault lies in the iron being a little harder, but is rather inclined to fall out with the whole institution as requiring something unreasonable. Forty-five feet per minute on cast iron is double what we have been accustomed to, and all day long the high-speed steel will show about the same tendency to become dull that the ordinary tempered steel formerly showed at 20 feet.

In taking light cuts in cast iron we may readily run up to 100 feet and even more per minute. On the same line of argument, 75 feet for steel in roughing would be more economical than a much higher speed on an entire day's run, because if the extreme high speeds were to be kept up all day, it would require a foreman or superintendent to about every three men, which we all know would not be at all economical. We have found more astonishing results, perhaps, in using this steel for the boring of spindles than in the turning. It will astonish some of our members, I know, when I say that we can bore 50 carbon steel all day long about as follows: Our 24-inch lathe spindle is 44 inches in length. In this we bore a 2⅛-inch hole, and we do this in 58 minutes. In an entire day's run, counting the mounting into the machine and the taking of it out, we average eight spindles on one machine in ten hours. Our 14-inch lathe spindle is 24 inches long, and in this we bore a 1¼-inch hole in 18 minutes. The tail spindle for the 24-inch lathe receives a 1⅛-inch hole its entire length, less two inches, and we can readily bore this hole every nine minutes.

On finishing operations and light cuts and in 30 carbon steel we do run up to 200 feet, and find on this class of work that a high speed and a fine feed are more economical than attempting a lower speed and coarser feed, preparing the work for the grinding machine so as to leave less work on the grinder. I know that this statement is not in accordance with the practice of some other concerns; but after having used the coarse feeds on work that was going to the grinder, covering a period of six months and tested out carefully, and comparing the results with those secured with a higher speed and a finer feed, we find the latter to be preferable. Moreover we can get closer to the exact diameter required, leaving less work for the grinding machine than when we used very coarse feeds.

We have been making some experiments on our drill presses with the high-speed steels and find that the most astonishing results may be had by taking flat drills in Novo steel and on account of the high speed possible do much more rapid drilling. The flat drill will do its work nearly as well as the twist drill if care is taken to have the cutting points ground with the same nicety that we would grind the cutting points on a twist drill, and, except in cases where blow holes are met with, we believe we are going to find great advantages in using this steel either for flat drills or straight grooved drills made from round stock. On planing work there is no difficulty at all in having tools stand for roughing operations up to 55 feet per minute, and even more than this on light cuts for finishing. In the matter of finishing cuts it depends a good deal on the piece as to the advisability of using a higher or lower speed; but we get very good results at highest speeds on finishing cuts, and the same thing holds good on lathe work.

We have recently been trying some rather interesting experiments on heavy tools by brazing flat pieces of high-speed steels on to machine steel; and as this steel is so exceedingly costly and particularly for heavy planer tools and heavy lathe tools, it might be wise for our members to look into this feature of economy. I shall be glad to show quite a number of these tools fixed in this manner. Of course, much higher speeds may be used in planing where the cuts are intermittent than where they are continuous or where the piece being planed is short. We also find that it is quite possible to use the Novo as a steel for finishing—for instance, as "V" thread chasing and at rates of speed never dreamed of in our old shop practice. It is our experience, and I judge the experience of nearly all other machine shop owners, that the tendency on the part of the men is to use as fine feeds and as low speeds as the man in charge will permit, and we find that the substitution of the premium system of doing work is of greater value in this particular than close superintendence or increased wages as applied to the regular daily rate.

CRUSHED STEEL AND STEEL EMERY.

Abstract of Paper read by M. M. Kann before the American Society for the Advancement of Science.

The author states that crushed steel is a well-known artificial abrasive which dates back its origin about fifty years. It was first used in some German industries where a harder cutting material than emery or corundum, was required. Resort was made to broken files, but the product was an expensive and uncertain abrasive on account of the difficulty in getting uniform fracture and shape of grain. Reference was made to the organization of a company for the regular manufacture of crushed steel in the United States. The Pittsburg Crushed Steel Company was organized in 1889 and after a vast amount of experimental work they were able to produce an artificial abrasive in uniform grains, structure and sizes, of the required hardness and toughness, and at a cost that enabled it to be placed on the market in competition with natural abrasives like emery and corundum.

This abrasive is manufactured preferably from pieces of high-grade crucible steel, heated to a temperature of about 2500 deg. F. and then quenched in a bath of cold water or other suitable hardening solution, which gives the steel a granular structure. The pieces are placed under powerful hammers or crushing machines, and are reduced to small particles, varying from fine powder to grains of many different sizes. The steel particles are then tempered, preferably in a cylinder or pan and heated to a temperature of about 450 degrees, F., until the particles change their appearance to a straw color; they are then cooled by being subjected to cold air in various ways. The material at this stage, or before the tempering process, is graded into many sizes, according to the number of mesh openings of the sizing screen per square inch. The sizes of diamond "crushed steel" run in numbers from No. 5 to No. 60 inclusive. Diamond "steel emery" is similar to crushed steel, but it is given an intensely hard temper, and its numbers range from No. 60 to No. 200 and above. These two abrasives, so closely related to each other, are used for entirely different purposes in the various trades. Crushed steel and steel emery rank very close to the diamond in hardness, being 9.27 if the diamond is taken at 10.

Crushed steel is tempered mostly to a tough hardness, while steel emery, having different work to perform, is made intensely hard. A grain of crushed steel, examined under a magnifying glass, exhibits a series of sharp points and cutting angles. In work, as fast as the point is worn down another is presented, while should a grain break it presents on the fractured face a multitude of new cutting points.

Crushed steel and steel emery are now used in the sawing, rubbing, and polishing of stone, marble, granite, onyx, etc., in lens grinding, glass beveling, brick grinding, and by lithographers, engineers, and plate-glass manufacturers. If a bond could be found, so that these steel abrasives could be placed on the market in the form of a wheel or brick, the length of the above list would be much extended.

After referring at some length to the various uses to which crushed steel and steel emery are put, which practically covers all abrasive operations except those requiring a solid material like grindstones, emery wheels, etc., the author states that engineers are finding out the value of this abrasive, which "cuts but never breaks." In grinding metal, the work which steel emery will do is considerable, and now all important railroads in the United States and Canada consider it an indispensable material in their shops. Hardened tool steel, against which emery instantly pulverizes, and which will resist the bite of a file, yields to the cutting power of these minute grains.

Lack of acquaintance with steel emery may lead the workman to believe that it has ceased to cut long before its power is exhausted. This is due to the absence of the peculiar grating sound produced in its operation, now deadened by the minute particles of abraded metal, which thicken the oil and so prevent the steel emery from doing its work properly. The addition of a little oil permits the grains of steel to move freely and new life is given them. In ordinary grinding and on flat surfaces steel emery is used in precisely the same manner as ordinary emery, but special care must be exercised in its use, because the grains of steel emery are so much smaller than the abrasive heretofore used for the same purpose. Oil must be applied sparingly to prevent the steel emery being drowned or floated away. On curved surfaces, or where there is a double seat, one above the other, it frequently happens that a lateral "dishing" or swinging movement cannot be given. Where such surfaces are to be ground, the work should be frequently lifted, so as to prevent grooving.

THE ARNOLD ELECTRIC-PNEUMATIC RAILWAY SYSTEM.

Western Electrician, May 2, 1903. p. 345.

The electro-pneumatic railway system invented by Bion J. Arnold, of Chicago, has been subjected to practical tests with gratifying success and is soon to be installed on a twenty-mile line in Michigan, the Lansing, St. Johns & St. Louis Ry, which has been built on private right-of-way and closely approximates standard steam railroad practice, and which it is expected will eventually be extended to St. Louis.

The general features of the Arnold electro-pneumatic system were given to the public in a statement presented by Mr. Arnold bfore the annual meeting of the American Institute of Electrical Engineers at Great Barrington, Mass., last June. (See MACHINERY, August, 1902.) Briefly considered, the invention consists of the use of a single-phase (or, if desired, other alternating-current) motor, operating at constant speed under constant load, the acceleration and retardation of the motor being accomplished by means of compressed air. The single-phase motor with which each car is equipped has both its armature and its field capable of revolution about the common shaft, either separately or together. An engine capable of compressing air is attached to the armature and a similar one to the field, and both are connected to an air-storage reservoir on the car. Each of these engines is also capable of driving, by means of the compressed air, that portion of the motor to which it is connected. Under normal running conditions the field magnet is at rest with respect to the car, and the armature, which is connected to the car wheels, rotates at its constant speed. Slowing down the motor is accomplished by releasing the clutch which holds the field motionless. The field begins to revolve and the field engine starts to compress air. As the speed of the car is decreased the rotation of the field is increased, and when the car is stopped the armature, of course, comes to rest, but its relative speed, with respect to the field, is maintained constant, and the field engine continues to store compressed air in the reservoir.

In starting the car the operations are practically reversed, the field engine being throttled, and, in addition, the armature engine is connected with the air reservoir and aids the armature in coming up to speed. Speeds above normal are secured by actuating the field engine by compressed air, the actual speed of the field being added to the synchronous speed of the motor. In ascending a grade the natural capacity of the motor is increased by the armature engine, and in descending a grade the energy of the motor may be entirely converted into energy of compressed air.

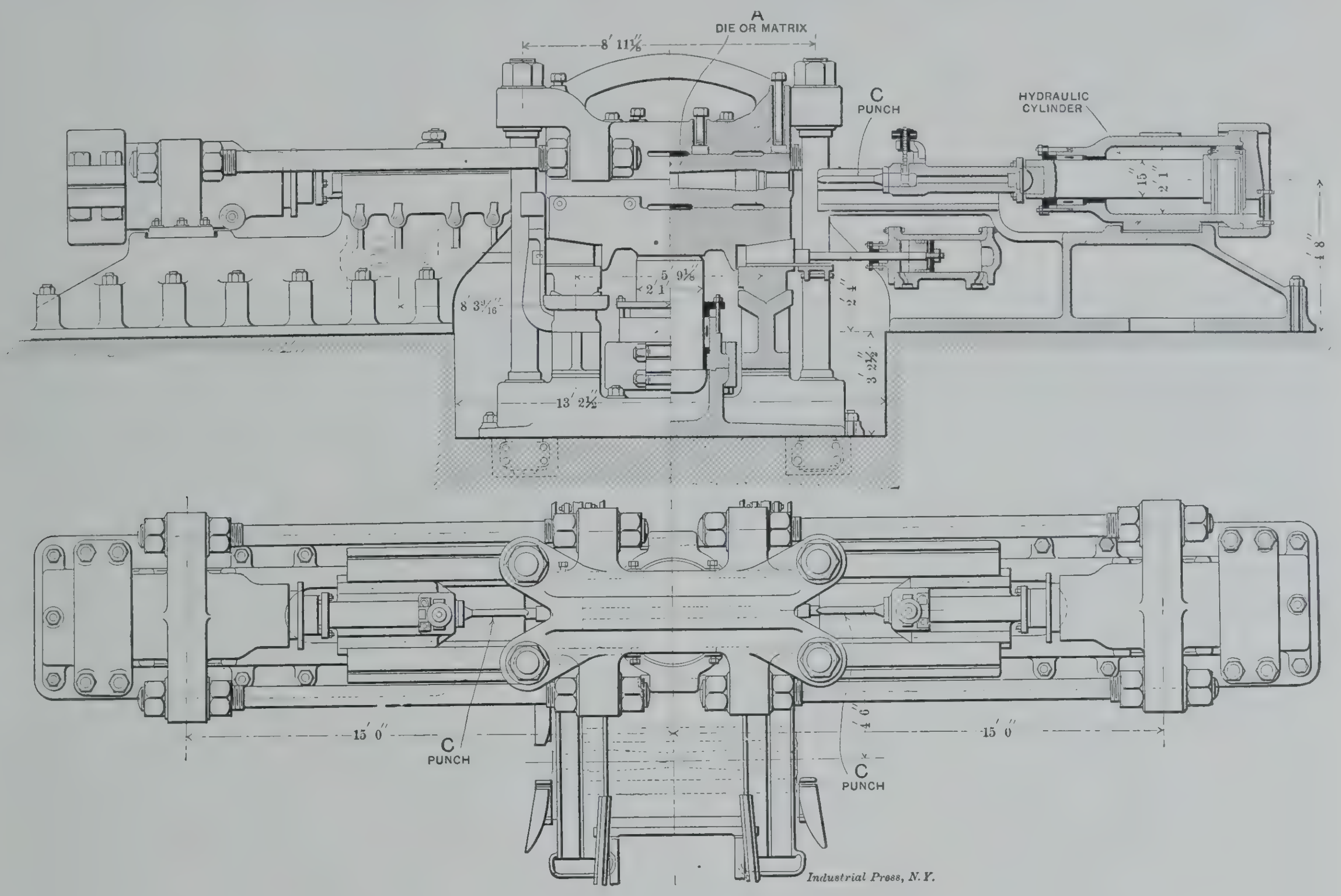
The signal advantages to be derived from such a system may be briefly stated as follows: The motor, operating at constant speed under constant load, will always work at maximum efficiency. The customary variations at the power house will be considerably decreased, as the different motors on the road will always carry the same load. By the use of the alternating current motors the elaborate and expensive system of rotary-converter sub-stations will be done away with, thus effecting a great saving in installation and maintenance. The energy now wasted in braking and in descending hills will be stored up for future use. Other advantages are the operation in towns and for switching by means of the pneumatic power alone, and the use of a high-tension, single-phase current with a rail return.

The Lansing road uses a 15,000-volt current on the line, and this potential is stepped down on the car to 200 volts, the working voltage of the motors. In passing through large cities the working voltage on the line may be reduced to the working potential of the motor by a stationary transformer, placed at the limits of the city.

HOLLOW PRESSED CAR AXLES

Abstract from Paper read before the May meeting of the Iron and Steel Institute by Camille Mercader. (London, Eng.)

The paper is an interesting exposition of the modern tendency to form iron and steel parts required to be made in large quantities, by heat and pressure rather than by cutting operations. It describes a method followed at the Carnegie Steel Co.'s works at Homestead, Pa., in the manufacture of hollow pressed car axles, which is one developed at the suggestion of the author. A rolled steel blank, uniformly heated, is inserted in a two-part die, *A*, Fig. 3, having a matrix cavity of the shape of a rough-turned axle. The diameter of the journals is made equal to the smallest diameter of the axle in the center, which also equals the diameter of the round blank. After the dies are clamped about the heated blank the latter is axially perforated simultaneously at both ends by two cylindrical punches, which force the metal of the blank to conform to the shape of the matrix die and fill out the same. The blank is heated up to 1,800 degrees F., and the total hydraulic pressure required for penetration with a punch of 3 inches diameter amounts to about 50 tons. During the last end of the stroke a total hydraulic pressure of about 150 tons is required because the blank loses its initial heat through contact with the dies and because the end collars upset, at which time the metal may flow back against the punch. The punch, being tapered, acts as a wedge and the pressure that can be exerted upon the axle blank is consequently enormous. To prevent the punches becoming overheated by contact with the hot metal, water circulation is provided, the punches being made hollow for the purpose.



Figs. 1 and 2. Hydraulic Press for Forming Hollow Steel Car Axles.

This great compression improves the quality of the steel in the central part of the axle by destroying the injurious effects of segregation and piping usually found in ingot steel. It is absolutely necessary to have the greatest possible uniformity of heat throughout the body of the blank, the temperature determining the resistance which the punch must overcome.

The advantages of a hollow pressed axle may be summarized as follows:

1. The axle has a perfect form; its shape can be best adapted to resist the strain to which it is subjected with the least amount of metal, combining minimum weight with maximum strength.

2. The forging effect being carried out throughout the material, both internally and externally, the material is found to be far more homogeneous than solid axles made in the usual manner; segregation is destroyed, and, consequently, the axle is much more reliable.

3. The journals being highly compressed, will in finishing, attain a more highly polished surface, thereby minimizing the friction, resulting in economy of draft.

4. The journals, being hollow, will remain cooler and permit the storage of a considerable quantity of oil, removing herewith the chief cause of hot journals, also economizing materially in the expenditure for lubrication.

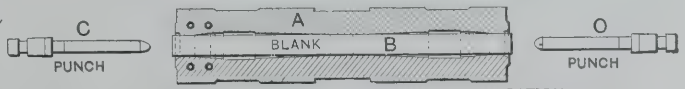
5. No straightening after punching is required, the axle being as straight as the die, thereby eliminating entirely the injurious effects of the gagging operation.

6. No centering, no cutting of the ends, no rough turning is required, thereby saving considerably in finishing labor and increasing the finishing capacity of existing plants.

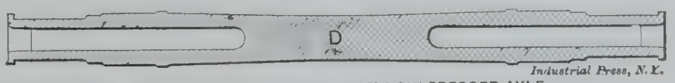
7. The punching of treble the amount of axles as compared with forging with an equal number of hands, resulting in saving of forging labor.

8. The detection of a defective axle without performing any extra work—that is, without the necessity of rough-turning it over all, which provision is now included in the latest M. C. B. specifications.

9. Approximately uniform fiber stresses throughout the body of the axle, due to the straight and uniform taper between the wheel seats.



TWO-PART DIE HOLDING BLANK FOR AXIAL PERFORATION.



SECTION THROUGH CENTER OF HOLLOW PRESSED AXLE.

Fig. 3.

10. A saving of 33 per cent. of steel in the manufacture.

11. The weight of a 100,000 pounds capacity steel car is decreased by 1.7 per cent., permitting this load, which amounts to 24,000 pounds in a train of 40 steel cars, to be carried without any additional expenditure of energy.

HEAT TREATMENT OF WHITE-IRON CASTINGS.

Abstract from Paper read by A. E. Outerbridge before the Annual Meeting of the American Society for Testing Materials, held at Atlantic City June 12-14, 1902.

In the year 1882, while engaged in metallurgical work at the car-wheel foundry of A. Whitney & Sons, in Philadelphia, my attention was called by the inspector of wheels to an unusual and remarkable change that had occurred in the chilled or white iron forming the "treads" of a number of wheels poured from one heat. This change was first observed on removing the wheels from the annealing ovens. It was customary for the inspector to prove the hardness of the chilled treads by testing them with a cold chisel all around the "throat" or place where the tread joins the flange. On this occasion he found a number of wheels which were quite soft on one portion of the rim, extending the entire width of the tread for a length of 6 or 7 inches, while on either side of the soft spots the chilled tread was so hard that the steel chisel slipped over the surface without biting. In order to study the nature of this singular occurrence I caused the wheels to be broken through the soft spots so as to examine the fracture, and I found that the white iron (chilled iron) had been changed into perfectly gray iron, evidently after the wheels had been cast. The change was not equally well marked in all of the wheels and the soft spots were smaller in area in some cases than in others, but in all, the dividing line between the white portion and the gray portion of the chilled tread was sharply defined.

It is perhaps necessary to state that in the establishment where these wheels were cast it was customary to pre-heat the annealing pits by means of soft-coal fires before the wheels were lowered into them, the flames passing through the pits or ovens. The rule was to close the dampers just before the pits were opened to receive the red-hot wheels, in order to shut out the flames.

After careful investigation, I found that through an oversight the dampers of the annealing pits had not been closed and the flames from the fires impinged upon the surfaces of three or four red-hot wheels in the lower part of each pit, causing a complete change of the carbon from the combined form to the free condition wherever the flames touched the castings.

Specific gravity tests showed that the gray cast-iron resulting from this accidental heat treatment of white iron differed materially in density from the normal gray iron forming the unchilled parts of the same castings; the specific gravity was about 7.80 as compared with specific gravity of about 7.20 for the normal gray metal; a cubic foot of the gray iron produced by this annealing process therefore weighed about 37.5 pounds more than a cubic foot of the normal gray iron of the same casting. It was noticed that the fracture was of much finer grain than normal gray iron, and "chips" or drillings of the annealed chilled iron differed greatly in appearance, size and shape from the chips or drillings of the normal gray iron made with the same drill.

Several metallurgists, to whom the pieces of annealed chilled iron were exhibited, offered a plausible explanation of the phenomenon, saying that it was merely an accidental conversion of the white iron into malleable iron, and therefore presented no novel features. The analyses quickly showed the fallacy of this theory, for the total carbon was the same after annealing as before annealing, being about 3½ per cent. in each case, while in the ordinary conversion of white-iron castings into malleable iron, a large part of the carbon is removed by the oxidizing material in which the castings are imbedded when subjected to heat-treatment, and this conversion of white iron into malleable iron can only be successfully accomplished on sections of metal of moderate thickness, say less than 3 inches.

Although this accidental discovery of annealing of white iron on the treads of car wheels was regarded as an interesting and novel one at the time, the only practical use made of it was to guard against a repetition of the accident in the annealing pits of the car wheel works with which I was at that time connected.

After the lapse of several years I was called upon to investigate in a professional capacity, and in the interest of some prospective investors, the merits of a new process of converting white-iron castings into steel, and received from the manufacturer a number of axes, hatchets and other edge tools, which had been cast in white iron and subsequently converted into a metal having evidently many of the qualities of steel.

Without describing in detail the process to which these white-iron castings had been subjected, I may say, briefly, that they were placed in the muffle of a furnace together with a chemical compound claimed to be necessary to the conversion of the cast iron into steel. Common salt and crude hydrochloric acid were two ingredients of this compound. The similarity between this process and the accidental over-annealing of the car wheels (with consequent change of the condition of the carbon) suggested to my mind that the chemical compound was probably unnecessary and that the secret consisted solely in the heat treatment, and I so advised my clients.

The conversion of white-iron castings into dense gray iron having high strength (approximating that of certain grades of steel) capable of being hardened and of taking a sharp cutting edge is no longer a secret, and is carried out on a commercial scale in a number of establishments. While I cannot speak positively, I am of the opinion that the heat treatment alone is now relied upon to produce the desired results. These products are not steel castings, though sold in some instances under the name of steel; neither are they malleable iron, but they may be described as occupying a peculiar position midway between cast steel and cast iron.

Although it is a misnomer to call castings, such as hatchets, axes, etc., made from white iron changed to gray iron by heat treatment and subsequently hardened on cutting edges, steel castings, they are certainly very different from true malleable iron castings or from ordinary gray iron castings, possessing qualities more closely resembling steel. If we can eliminate the false name of "steel" which has been given to converted white iron castings, a distinct advantage will have been gained, for I believe that the new metal is worthy of taking a special place in the metallurgical arts, and I anticipate extended practical applications of the process as knowledge of the proper methods of heat treatment and of the valuable properties (as well as the equally marked limitations) of the metal shall become better known and appreciated.

* * *

TEXT BOOKS.

In a circular issued to the alumni of the Massachusetts Institute of Technology, with reference to various matters connected with that institution, is a paragraph upon text books which expresses an idea that will be appreciated by all who have occasion to use works of reference on engineering subjects.

"Text books are largely unsatisfactory. While they may be written by men who have knowledge of their subject, their authors usually have but little experience in the presentation of the subject or the systematic arrangement of a book. As a result we have many books with good subject matter poorly presented, some so poorly as to render them of little value as works of reference. It would seem that a very important function of any school, especially of a technical character, would be to provide the best sort of tools for its students, and it is suggested that no more important branch of any such school could exist than one systematically taking care of the preparation of proper text books. A systematic handling of this text book matter would be of value, not only to students, but to graduates or engineers. To show that this point is of value, we cite the case of the International Correspondence School, at Scranton, Pa. This school was started in 1891 with a capital of $12,000, and now has a capitalization of $3,000,000. A large part of its success comes from its systematic text books, treating in a uniform, clear, concise, and very simple manner the various subjects which it gives. It offers something over one hundred courses, and has prepared text books for them all. The text writers of these books are not men of note, and yet the books are of value to men in their profession on account of the uniform and systematic treatment. We have only to point out how great is the value of text books written by men most eminent in their profession and edited in a systematic manner."

* * *

One thing about the heavy, high-speed, high-powered automobile that recommends itself to the traveling public, is that it is undoubtedly the best vicious dog killer ever invented. The dog who gages his provoking antics to the pace of the ordinary horse-drawn vehicle, is totally unprepared for the speed of the automobile and often before he knows it he is rolled ignominiously in the mud—usually with serious results to his dogship.

THE INSPECTION DEPARTMENT OF THE GARVIN MACHINE CO.

The inspection department and stock room of the Garvin Machine Company, New York, covers a space 30 x 81 feet on the north side of the second floor of their eight-story machine shop at the corner of Spring and Varick Streets. The halftone, Fig. 1, shows the stock clerks' desks, the inspectors' benches and a portion of the stock racks. Fig. 2 is the floor plan. It will be observed that the arrangement is such that the work for inspection enters at the receiving window, or door, passes the inspectors' benches and then goes either to the stock racks or to the delivery. All work that is of a size that it can be conveniently handled, such as gears, cams, disks, pins, screws, studs, collars, spindles, dials, brackets, collets, shanks, index plates, centers and the thousand-and-one other small parts that go to make up the construction of the variety of machinery built here, passes through the inspection department at least once, and in some cases two or three times. This latter, of course, applies to such parts as require a series of operations, the accuracy of each of which depends upon the preceding one. The larger parts such as frames, tables, etc., are inspected on the shop floors wherever they may be located, and the assembled machines are inspected at various stages of the assembling and when completed, on the erecting floors.

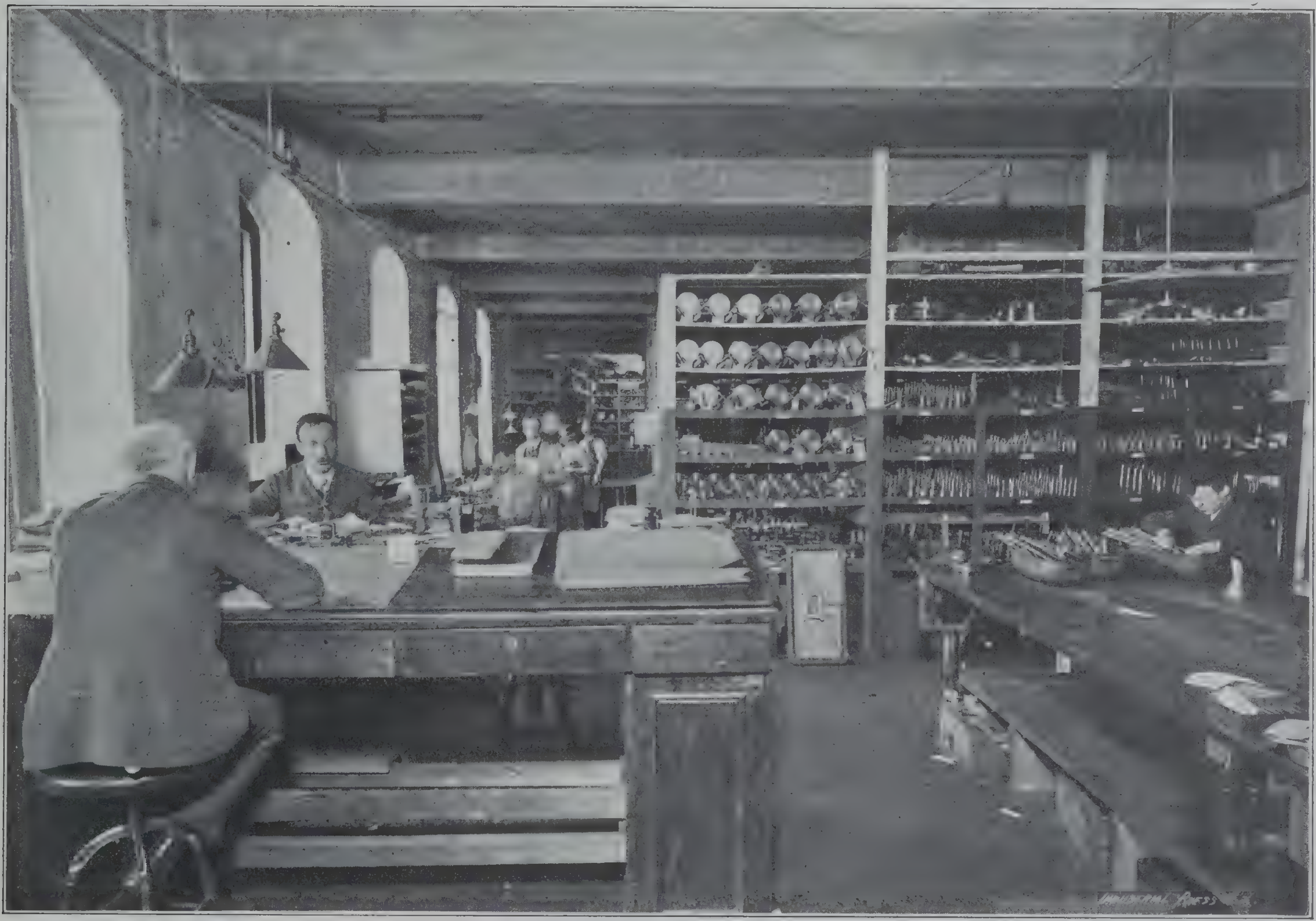


Fig. 1. General View of Inspection Department of the Garvin Machine Co.

Inspection is interpreted to mean something more than mere measurement and gaging of parts: they must pass a certain standard of finish and general appearance which, of course, is well within the province of the department. The "personal equation" is also recognized, as it must always be in any human institution; machine parts finished by men of good mechanical standing may not in all cases be subjected to the searching investigation given the work of the party who has the reputation of "letting things slide." While it might be argued that in a well-appointed shop there should be no room for a representative of this class, the practical difficulties of getting first-class machinists in large cities make it imperative to keep some of them. The work can then only be kept up to a high standard by close inspection and "firing back" such parts as do not fulfill the standard requirements in every particular. So prone is this class to overstep the limits allowed that they (the limits) have in many cases been made closer than really necessary for commercial work. Thus if the requirement of accuracy for any part should necessitate its being within 0.003 inch the shop limits would be set at, say 0.002 inch, which condition gives the inspector a chance to exercise some discretion in the matter of passing work. In case any part is passed in which appears a minor defect that in no way injures the working of the machine, the fact is noted and a record kept along with the record of tests.

The inspectors' benches are equipped with long surface plates which are provided with T-slots the same as a milling machine table. In fact, the plates are tables that have been adapted for this purpose. Such parts as dividing heads are set up on these surface plates and tested with reference to the top surface of the plate, and to the positive side of the middle T-slot. The parts of a dividing head have all been inspected separately before it goes to the inspection department in the assembled form. The taper hole is again inspected for fit of the taper center, a test bar is put in to test the running of the taper hole and for parallelism in a horizontal direction when the head is set at zero, and then it is tested sidewise from the positive side of the T-slot. The alignment of the head and foot stock centers is tested to determine their accuracy. The spindle is set perpendicular to the base of the head to determine the accuracy of the graduation and its relation to the main spindle.

When these tests have been concluded an accurately cut disk about 8 inches in diameter, having 40 teeth and mounted on a taper mandrel, is applied, the mandrel being slipped into the spindle hole. The test indicator is set to the positive side of one of the teeth on the horizontal diameter so that the pointer stands at zero. The handle is then revolved once, thus turning the disk one division. The test indicator is then applied and the reading taken. The operation is repeated for each tooth and the readings recorded on special sheets prepared for the purpose. When the error is in one direction it is marked +; in the opposite direction, —. The arithmetical sum of two greatest deflections from zero, + and —, are recorded as the error of the head. Thus, if the reading at starting is 0; at the tenth division, + 0.0015 inch; at the twentieth, 0; and at the thirtieth division, — 0.0015 inch, the total error would be 0.003 inch.

It would be an interminable and most difficult job to test the accuracy of the holes drilled in the index plates, and it is not attempted. The method of producing them and the fact that any error of spacing is reflected in the movement of the dividing head spindle in the ratio of 1 to 40, so that it would require a serious error in the index plate to produce an appreciable error in the spacing of the spindle, are taken into consideration. The index plates are drilled under a sensitive drill press, using a Brown & Sharpe master plate for indexing. The drill is guided by a bushing in the manner described in the April, 1903, issue. The master plate is made of considerable thickness, but the indexing pin enters it only a short distance. At such a time that it is found that wear of the master plate has affected its accuracy, it is removed and the surface faced off, leaving a series of sharp-edged unworn holes for the index pin, which is then set further up to engage with them. This, of course, restores the original accuracy to the device. This is mentioned as an instance where absolute inspection is both unfeasible and unnecessary because of the method of manufacture and the relation of the piece to action of the machine.

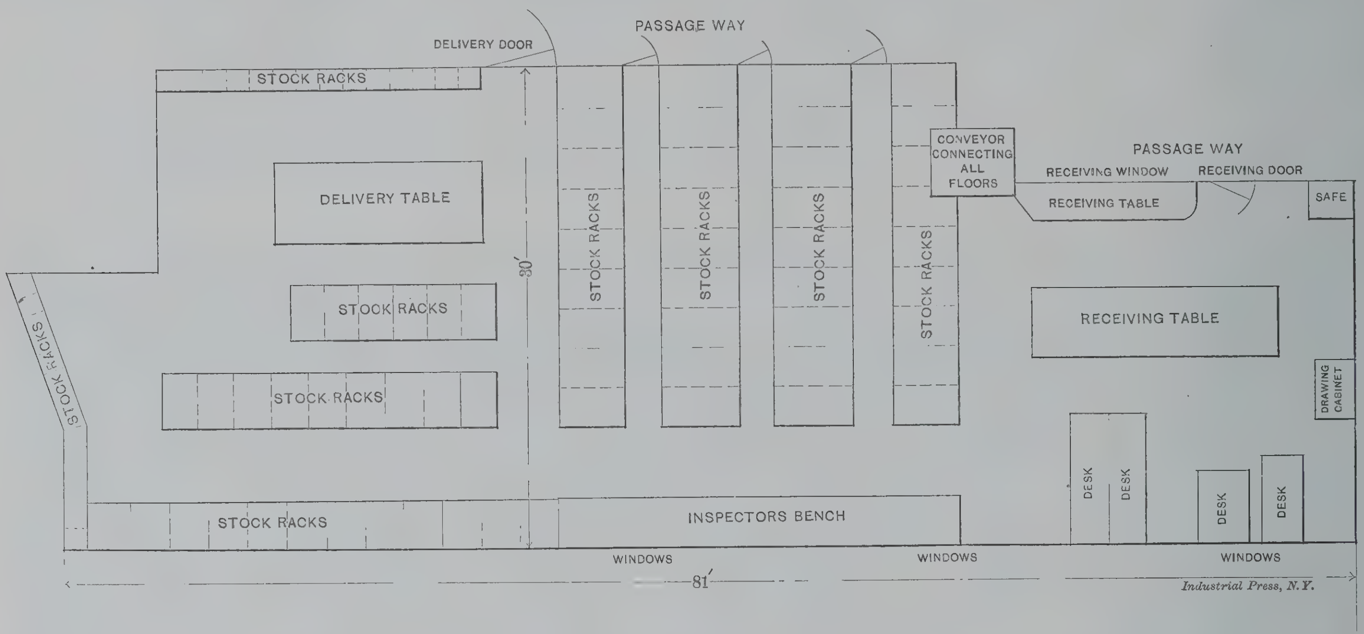
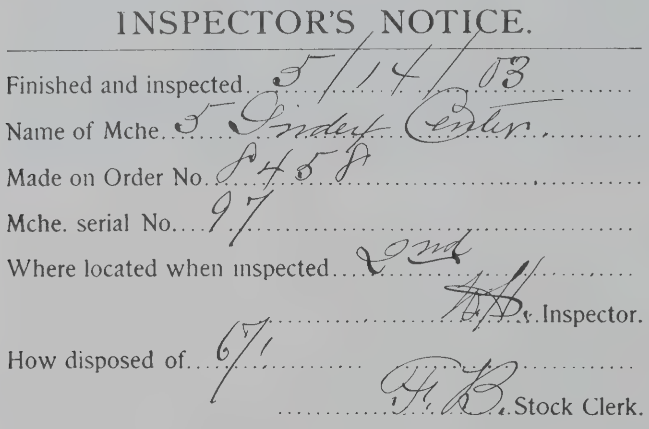


Fig. 2. Plan of Inspection Department, Garvin Machine Co.



INSPECTOR'S NOTICE.

Finished and inspected 5/14/03

Name of Mche. 5 Index Center

Made on Order No. 8458

Mche. serial No. 97

Where located when inspected 2nd

Inspector.

How disposed of 67'

H. B. Stock Clerk.

Fig. 3. Specimen Inspector's Notice.

In the April issue mention was made of a combination boring machine for boring the holes in milling machine frames at one setting. The accuracy of this machine has an important influence on the product, and the fact that it does produce accurate work makes the alignment of the spindle, overhanging arm and knee a comparatively easy matter. Inspection is made after the holes are bored, and if found "out" the error is corrected by scraping the holes in the boxes and the front surface against which the knee is clamped.

The assembled machines are tested for alignment with the the following limits allowed in the case of plain milling machines: Alignment of knee with spindle in horizontal and vertical planes, 0.003 inch in 14 inches; top of table with spindle 0.0015 inch in 5 inches; slot in table at right angles to spindle 0.003 inch in 30 inches; ways of table with slot 0.001 inch in 12 inches; overhanging arm with spindle 0.002 inch in 14 inches; outboard bearing with spindle 0.002 inches high or low.

In regard to keeping the shop gages accurate the chief inspector says that the men largely take the initiative in seeking that the gages be corrected, if they have reason to suspect them worn sufficiently to be inaccurate. Of course, it is to the self-interest of every employee that the gages he uses are right; otherwise he will be responsible for a lot of defective work which he must make good. It thus appears that under a moderately rigid inspection system the correction of the shop gages is largely automatic, in the sense that the men act as their own inspectors in this regard.

* * *

The National Machine Tool Builders' Association, at their October, 1902, meeting in Cleveland, O., passed a resolution to hold the next meeting at Worcester, Mass., in April, of the following year. As many members of this Association are also members of the National Association of Manufacturers and of the Metal Trades Association whose conventions took place in April, it was decided to postpone the meeting of the National Machine Tool Builders' Association. This convention, it is officially announced, will be held on Tuesday, June 9, at Worcester, Mass.

* * *

In his book, "The Great Siberian Railway from St. Petersburg to Pekin," Michael M. Shoemaker makes a curious statement regarding American locomotives which he saw near Port Arthur. "As we were moved around the yards I notice a very familiar sound to the locomotive, which I find is one from the Baldwin Works in Philadelphia—poor specimens of American engines; certainly not such as the Balwin Works are in the habit of turning out." Probably Mr. Shoemaker does not realize how essential to the life and well-being of a locomotive, is good care. Judging from what he says of the average Russian in his book we should not expect the Russian engineer to keep his engine in very excellent shape. It is absurd to blame the builder for the bad appearance of his product which is in the hands of presumably careless and untrained men.

ILLUSTRATIONS* OF THE VARIOUS USES TO WHICH A MODERN SAW BENCH CAN BE PUT.

I. MC KIM CHASE.

In consequence of the diversity of pattern work the machines usually found in woodworking establishments for doing one particular kind of work are not well adapted for use in pattern shops. The most useful machines for the pattern shop are those that will admit of various kinds of work being done on them. A patternmaker will use a machine some minutes to do a part of a piece of work he is engaged upon. Another workman will follow him with work requiring the use of the machine in quite a different way. Within the past few years several machines have appeared on the market specially designed for use in pattern shops that will admit of them being used in a variety of ways. Not the least important of these machines is a combination saw bench. These benches have two circular saws, a crosscut and a rip saw. The arbors of the saws are journaled in a revolving frame and by means of worm gearing either saw may be raised above the top of the table to make any desired depth of cut that the diameter of the saw will allow. This makes the machine convenient for cutting grooves, roughing out plain, round core boxes, and similar work. Another important feature embodied in these machines is a slide which forms a part of the top and to which the fences and guides are attached by dowel pins.

The tops of these benches are usually graduated and have holes provided for the dowel pins so that the fences may be set at various angles. To illustrate the various settings possible on some up-to-date machinery the accompanying cuts are largely self-explanatory.

Fig. 1 shows the top of the bench arranged to cut the segments required to form an octagon.

Fig. 2 shows the arrangement for cutting the segments for a triangle. By setting the fence at the required angle, for which holes are provided for the dowel pins, all of the most important angles may be cut, such as miters, angle to form pentagon, hexagon, etc. (See Figs. 8 and 9.)

Fig. 3 shows a special fence and gage for sawing the ends of segments for circular work. Every patternmaker can appreciate this handy device, as by its use the building up of segment work can be expedited.

Fig. 4 shows the top of the bench tilted and arranged to cut compound or flaring angles, such angles as required for the sides of trays, hoppers, etc.

Fig. 5 is the arrangement for cutting staves for cylinders, large core boxes, etc.

Fig. 6 shows how the top may be tilted and, in combination with the fence, any shaped prism, such as square, triangular, hexagonal, octagonal, etc., may be cut.

Fig. 7 shows the arrangement for performing a very important job, and one frequently required in making patterns. It is that of working out the inside of a plain cylindrical core box. The angular position of the work relative to the saw, and its line of travel, produce a close approximation to a semicircular concaved shape which can be afterward trued up with the core box plane with a minimum of labor.

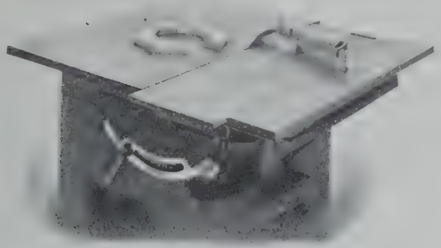


Fig. 1. Sawing Sections for Octagons.

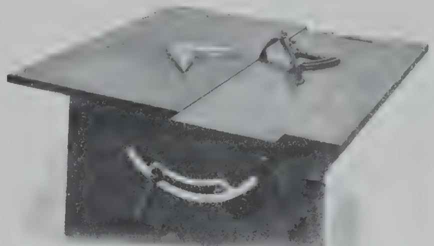


Fig. 2. Sawing Sections for Triangles.

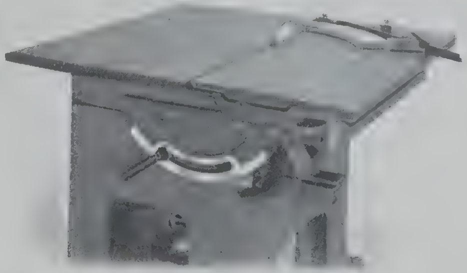


Fig. 3. Sawing Segments for Pattern Work.

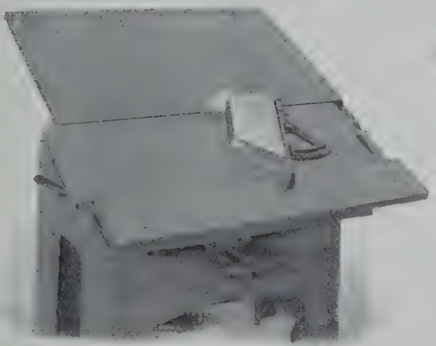


Fig. 4. Sawing Compound or Flaring Angles, such as the Sides of Trays, Etc.

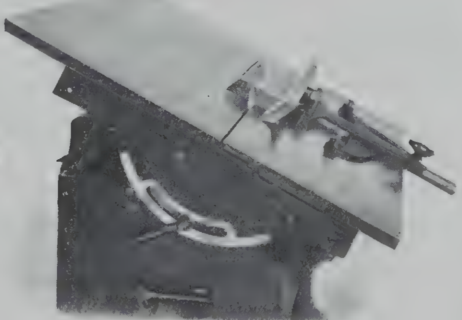


Fig. 5. Sawing Bevels for Cylinder, Column and Similar Patterns; also Cisterns, tanks, Etc.

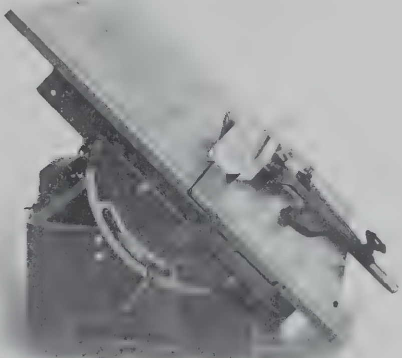


Fig. 6. Sawing Newel Posts, Etc. Table can be tilted to square, octagon, hexagon, etc.

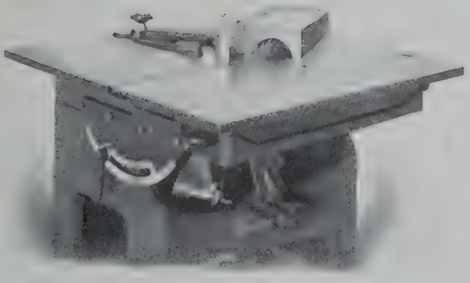


Fig. 7. Sawing out Round Core Boxes.

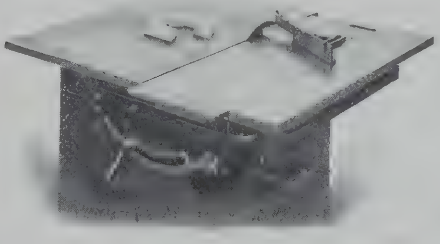


Fig. 8. Sawing Sections for Hexagons.

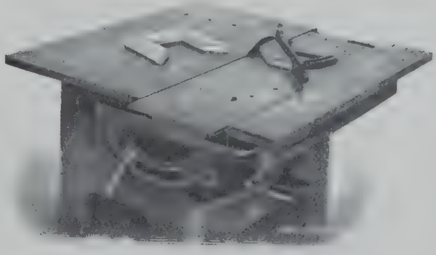


Fig. 9. Sawing Miters for Square Frames, Etc.

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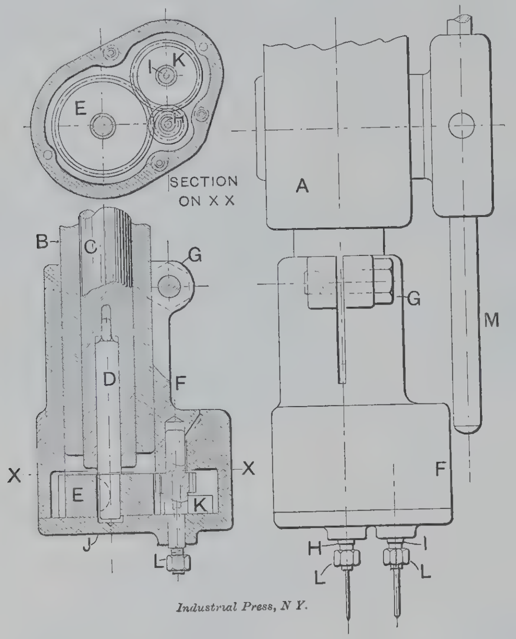
*The illustrations accompanying this article were made from photographs of a saw bench manufactured by the Colburn Machine Tool Co., Franklin, Pa.

LETTERS UPON PRACTICAL SUBJECTS.

A DUPLEX DRILLING ATTACHMENT.

Editor MACHINERY:

An operation that is carried on continuously, day after day, and week after week, will well repay the cost of tools a little more elaborate than those required for occasional work. The illustration represents an arrangement for drilling two holes at once on repetition work of this kind. The piece to be drilled is a chain link used in a certain class of textile machinery and has two holes, about 15-16 inch apart, which are respectively .050 and .100 inches in diameter



Industrial Press, N Y.

A Duplex Drilling Attachment.

A is the adjustable head of a sensitive drill and *B* the sliding sleeve carrying the spindle *C*. To the taper hole in the end of the spindle is fitted the shank *D* which drives, through a key, the large gear *E*. *F* is a brass casting which encircles the sleeve *B* and is clamped thereto by the bolt *G*. This casting is provided with bearings for two small spindles, *H* and *I*, whose lower ends are supported by the brass cover plate *J*, which is screwed and doweled to the main casting. The spindle *H* is driven, from large gear *E*, by a pinion made integral with it, while spindle *I* is driven by the pinion *K*, keyed to it and also meshing with the gear *E*. The diameters of these two pinions are so proportioned to the driving gear that each drill is given a speed suitable to its diameter. The spindles are bitted out to fit the drills, which are held in the split ends by screwing up the nuts *L* on the tapered thread. The mechanism is entirely covered so as to be free from flying chips, and ample provision is made for oiling. The motion of the spindle *C* must, of course, be reversed in order to use right hand drills. The feeding is done as usual, by the pilot wheel *M*.

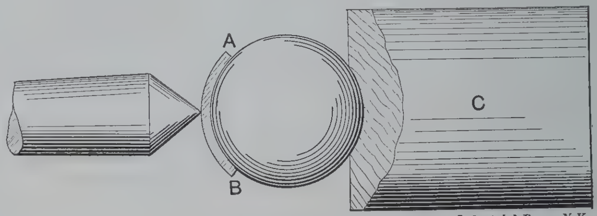
R. E. F.

TURNING A BALL.

Editor MACHINERY:

To make a ball as nearly perfect as a billiard ball is not a piece of work that a machinist or patternmaker has often to contend with, but sometimes there is a necessity for such work. There are several cases in which ball valves are used, such as in pumps where chips, dirt, or sawdust are liable to get under the valve seat, or in tannery works where small pieces of bark are apt to be mixed with the liquid. The rolling action of the ball has a tendency to remove the obstructions and let the valve seat fairly. Costly machines have been made for the purpose of turning balls, but the method here described is capable of producing just as good results on an ordinary lathe.

To make the pattern of the ball, first turn the piece on centers, using the calipers to get it somewhere near to the shape. Then cut off the centers and make a chuck block, of hard wood, as shown at *C* in the sketch. This is cupped to suitable shape to take in a small section of the ball. For the outer support use a blunt wood center, or an ordinary steel center with a strip of copper between the point and the work. Put the piece in the chuck so as to take the first cut around in the direction of its first centers. Take just a light chip, a narrow ribbon, and do not try to turn a wide space. Having turned it round in this direction, change the chuck so as to make another turning at right angles to the first, using the first cut as a guide to the depth of this second turning. Then change the work so as to make a turning between these cuts and continue to change it around until the entire surface has been turned, when it will be a perfect sphere. When it comes to finishing up the casting, bolt the chuck block to the faceplate and use the regular tail center with a concave piece of copper, as shown at *AB*. Use a hand tool or scraper after getting under the scale.



Industrial Press, N.Y.

Arrangement for Turning a Ball.

R. B. OTIS.

Leeds, Mass.

A COMBINATION PUNCH AND DIE.

Editor MACHINERY:

The cuts on the next page, Figs. 3 and 4, show a combination die and punch that is used for cutting out, bending, perforating and ejecting from the press such an article as is shown in Fig. 2. This is a plate, 6 inches by 4¼ inches, with the sides ¼ inch deep, bent over at right angles with the face of the plate. It is made of aluminum, brass, or tin, and forms the back part of a metallic picture frame.

In operation the outside cutting edge of the punch comes in contact with the inside cutting edge of the die, thereby cutting out the blank shown in Fig. 1. The punch, then continuing its downward travel, forces the blank over a forming plate, which is fastened to the inside of the die, so as to bend the sides to their proper shape. At the same time two small punches perforate the holes in the back of the plate. The punch then rises and the finished product is ejected from the press by a set of knock-out devices.

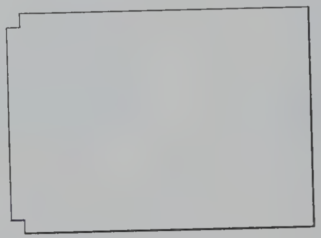
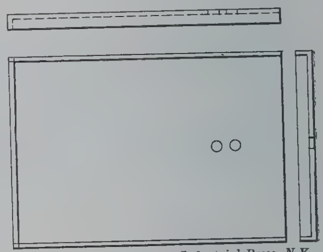


Fig. 1. The Blank.



Industrial Press, N.Y.

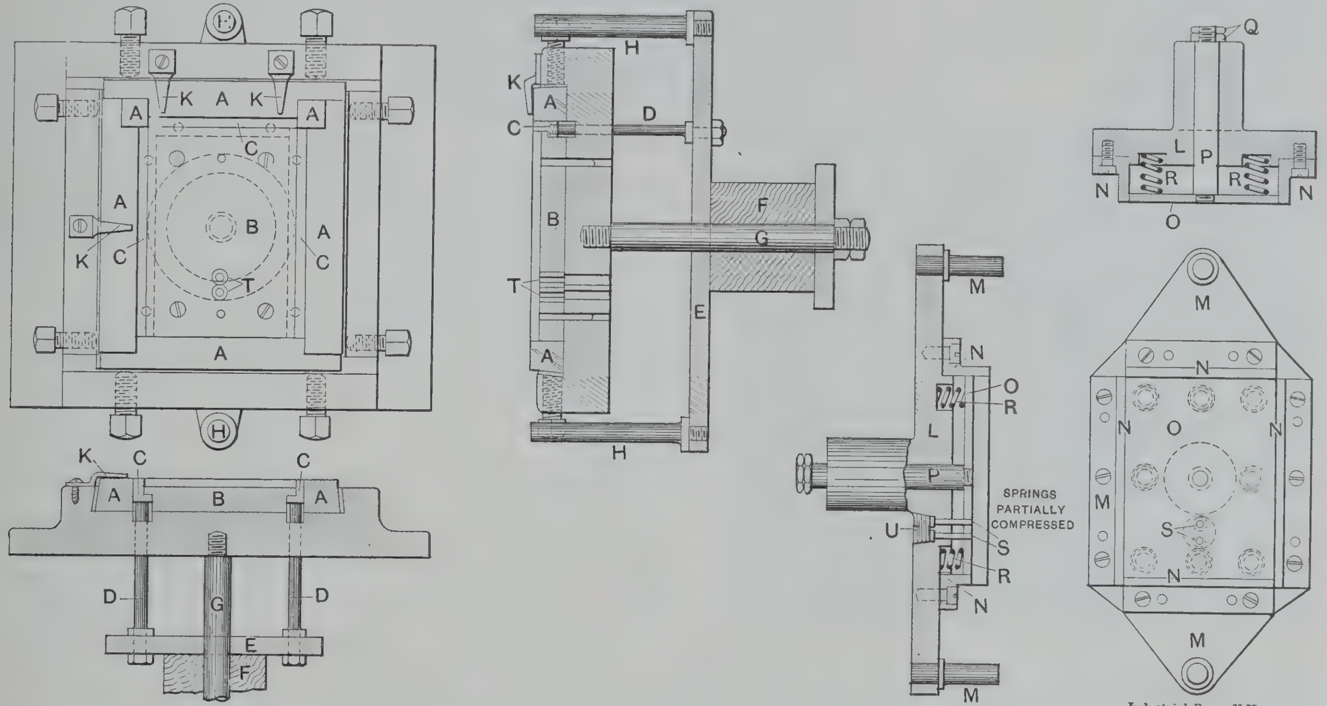
Fig. 2. The Finished Piece.

Fig. 3 represents the die or bottom part of the mechanism. It is composed of a cast iron or steel shoe, or bolster, the sides of which are beveled out on the inside at an angle of about 10 degrees. Held within this shoe are six tool steel sections, *A*, *A*, which form the cutting die. These are hardened and ground all over and when put together the space between the cutting edges is of the exact shape of the blank, Fig. 1, allowing no clearance on the inside of the cutting die. The four outer sections are beveled at an angle of 10 degrees, corresponding with the bolster, and thin strips or liners are inserted between the dies and the shoe, the whole being locked tightly by means of setscrews. The die sections project ¼ inch above the top of the bolster to allow for grinding the die. A tool steel forming-plate *B* of the size of the inside of the plate is fastened to the inside of the bolster by means of flush head screws and dowel pins. This is ground all over and the upper edges are slightly rounded off with an oil stone to prevent cutting or scratching of the plate. Between the forming plate and the inside of the die are the three L-shaped pieces *C, C, C,* which form the knock-out mechanism. They are connected by the bolts *D, D,* to the plate *E.* Beneath this plate is placed the rubber spring *F,* which is held to the central stud *G* by a washer and check nuts. At the ends of the knock-out plate are two vertical studs, *H, H,* which are of sufficient length to come up even with the top of the die. As the punch descends it encounters the tops of these studs and forces down the knock-out plate and with it the L-pieces, thereby drawing them out of the way of the part of the blank that is being bent over. As the punch rises and the pressure on the rubber is released these pieces rise and eject the finished work from the die. Three steel gages, *K, K, K,* are fastened to the top of the shoe and are bent over the top of the die to within 1-16 inch of the cutting edges, thus forming a gage for the material as it is placed in the die.

The punch, which is shown in Fig. 4, has a soft steel punch holder, on the front and back ends of which extend flanges of sufficient length to bring the studs *M, M,* opposite the studs *H, H,* in the knock-out plate of the die. The center of the face of the punch holder is elevated ¼ inch above the rest of the plate for a space equal in width to that of the finished product and ¼ inch less than its length. Against the edges of this elevation are placed the punch sections *N, N,* which are of tool steel, hardened and ground. When fastened in place the outside dimensions should equal those of the blank, Fig. 1, and fit between the cutting edges of the die. The inner corners should be slightly rounded with an oil stone to prevent cutting or scratching of the stock when turning over the edges of the blank. The space between the inside of the sections is equal to the size of the finished blank, Fig. 2. A tool steel plunger or plate *O* forms the knock-out device. This is not hardened but is nicely machined to fit between the punch sections. A tapped hole in the center receives the stud *P,* which projects through the shank of the punch holder and is held by the check nuts *Q.* Between the plate and the holder are placed the springs *R, R,* which are of sufficient length to produce a tension on the back nuts *Q* when the plate is flush with the face of the cutting sections of the punch. Two small punches *S, S,* are fitted into the punch holder opposite the small dies *T, T,* in Fig. 3. They are long enough to project ⅛ inch beyond the plunger plate when it is fully compressed inside of the holder and are fastened in the plate by the screw plug *U.* These serve the purpose of perforating the two small holes in the back of the holder.

H. Robinson.

Montclair, N. J.



Industrial Press, N.Y.

Figs. 3 and 4. Combination Punch and Die used for Forming Picture Frame Backs.

THE CUTTING POINT.

Editor Machinery:

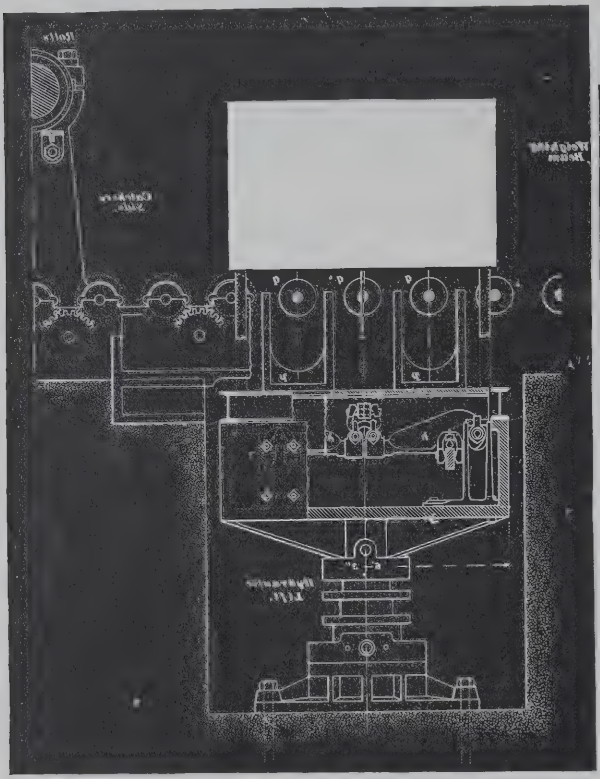
When one stops to consider he cannot but be impressed with the vital bearing that the point of the cutting tool plays in the profit of any manufacturing concern. The amount of work that a machine will do is more often limited by this than by any weakness of the machine or its drives. The output of the heavily built lathes and planers, with their special drives, may be reduced to that of ordinary machines by the improper treatment of the cutting tool, either through ignorance or carelessness. Mr. Markham's recent articles in Machinery have pointed this out, but how many of us realize to what an extent it affects every-day work in practically every shop in America? Whether you are using any special steel or not, there is a right way to treat it for best results and a tool that is not in its best condition is reducing the output of a machine that may have cost several thousand dollars.

Perhaps we have been too economical to buy a good heating furnace and a few other appliances for the hardener, and we are "getting along" with the old forge where it is simply impossible to heat large tools uniformly or without forcing the fire so hard that the air blast strikes the steel. The tools cut, of course, but do we count the cost of stopping the machine more often to grind or change tools? Or the difference in the total day's work when the machine cannot be run up to its maximum capacity? But the loss is not confined to tools of this kind when the new air-hardening steels are doing so good work. If your milling machine cutters are not in their best possible condition the difference in the amount of work that can be done will go a long ways toward putting in proper facilities for hardening and tempering. "Standing up" under a heavier feed, or needing fewer grindings, means more in the cost of production than we are apt to realize. Taps, dies, forming cutters and other tools come under the same category with the added feature of being more apt to be cracked in hardening. The spoiling of a tool, that perhaps represents several days' labor, from lack of knowledge or facilities means not only the direct loss of the tool but often serious delay to the work for which it was intended. When I recall the milling cutter with numerous teeth missing from "fire cracks," as we called them, taps minus part of their cutting edges and dies that were sprung out of shape I wish that we had known how to handle steel years ago. "Fire cracks," by the way, used to be our scape-goat and if a tool showed these cracks all hands were usually exempt, sometimes including the hardener. I used to do something in the hardening line myself and do not recall many serious mishaps although without doubt the tools were worked far below their best capacity. Many of the tools were hardened on an old portable forge, although they were too large for this to have been attempted, and if the cost sheets were accurately made out the amount of work which these tools did was probably way below normal. And so it all comes back to the first statement that the efficiency and economy of our up-to-date tools depend on the condition of the cutting point of the tools. I believe there is a larger return for the money invested to be had here than in any other place in the shop.

New York, N. Y. FRED H. COLVIN.

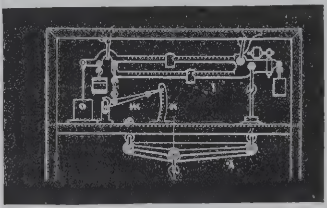
PLANS DRAWN QUICKLY.

Editor MACHINERY:



In order to effect the sale of a large amount of their machinery to a foreign customer, an American firm was asked to submit plans at once with their "tender" showing the full construction of the machine, including certain changes asked for by the customer. These changes were slight and were not in themselves difficult to make. The plans, however, were in the form of tracings, quite elaborate and in use every day. The firm did not wish to make any changes on the tracings, neither did they have sufficient time to make new ones. It was about decided to take off blueprints from the original tracings and make "stickers" showing the changes, which could then be pasted on over the original print. This is always a makeshift and in this case was strongly objected to, since the customer might possibly infer that the machines were manufactured in the same slipshod manner. In this emergency one of the draftsmen became inspired with an idea which prompted him to make the following offer: "If you will give me an order on a photo supply house for some paper, I will agree to make all the changes required and have the plans printed and ready to mail to-morrow morning." As no one had any better proposition, and as he seemed confident of his ability, a *carte blanche* requisition was given him. Although this was a hurry order he did not appear in any haste, but proceeded leisurely to make a small tracing showing the changes, then spent the rest of the afternoon lettering a very elaborate title stating that the machine was designed specially for "So and So," naming the intending purchasers. He went home to supper with the rest of the boys, and on his way back to the office in the evening he stopped in at the photo supply dealers and on the strength of his requisition obtained a package of bromide paper of the size of his drawings (the kind marked "thin, hard," is the best for this business). After dark—for this paper is very sensitive to the light—he loaded a printing frame as though to make a blue print, using the bromide paper in place of the blue. He put in the tracing *bottom side* up, so that the lines came in contact with the paper. After exposing the frame to an incandescent light for about 15 seconds he developed and fixed the print according to directions accompanying the paper, thereby securing a negative like the one shown in the illustration. As you will see, everything is reversed, dark for light, and left for right, so that the lettering, etc., reads backward, this latter feature being the result of turning the tracing over. After this negative was washed and dried, he cut out the portion which was to be changed, and inserted the print shown at the right, which he had made embodying the changes, covering the joint with black court plaster.

In this simple and inexpensive manner, with only a few hours' work and without defacing the original tracing, he secured a complete negative embodying the changes so neatly that the alterations would not be noticed. From this negative it was an easy matter to make the necessary number of prints on the bromide paper, the resulting copy showing black lines on a white ground, giving the effect of an original drawing even to the slight gloss of the ink lines. This feature is quite an advantage when the plans go to England, as in that country the appreciation of handwork amounts almost to worship.



Drawings on paper can be copied in the manner described, being careful to load the frame so that the ink lines will be in contact with the sensitive paper. Of course paper drawings require a longer exposure than tracings, a drawing on white paper like a patent office drawing requiring two or three minutes by an incandescent lamp, while a drawing on buff, "duplex," or detail paper could hardly be printed by artificial light as the yellow color retards the printing to that extent.

Velox paper can be used equally well, except that it is very much slower to print. This difficulty is largely offset by the fact that it can be handled with much less care as regards the light. W. H. SARGENT.

St. Johnsbury, Vt.

PUNCHES AND DIES USED IN MAKING RIM FOR LENSES.

Editor MACHINERY:

The accompanying drawings show three dies and punches that are used to produce the ring shown in Fig. 1 in three successive operations. This ring is used as a rim for holding lenses and the construction of the dies may be of interest to those who have occasion to make a set of tools for any similar article. The material from which these rims are made is "half-hard brass," as it is called. In Fig. 1, *A* shows the punching after the first operation, while Fig. 2 shows the punch and dies by which the operation is performed. The forming punch *C* was first turned to the outside diameter of the lens and a templet of soft wire, representing the cross section of the rim, assisted in obtaining the proper form of the face. The hardening of *C* was postponed until the last, as the two holes for the screws *G*, *G*, were not drilled until the die had been assembled. The punch *M* was then turned, leaving it a little larger than finished size, and while in the lathe the recess and the hole for the knock-out mechanism were drilled. By the use of the templet the recess *X* was turned out nearly

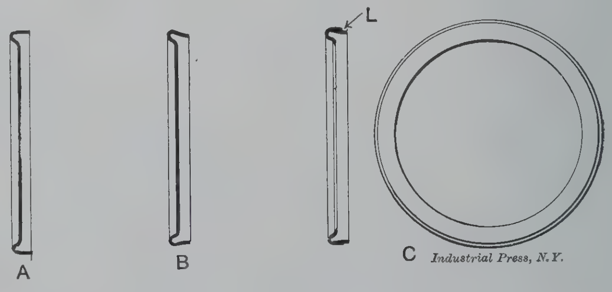


Fig. 1. The Successive Operations by which the Ring is Formed.

to size. The templet was then soldered across the face of *C* and with the help of a little red lead, to show up the high spots, this recess was readily finished correctly. To obtain the diameter of the cutting die and punch, *B* and *M*, the wire templet was unsoldered and straightened out. After the outside of *M* had been turned to this diameter it was taken to the gas furnace and hardened. As no grinding facilities were available, great care was taken to heat the punch slowly and evenly with the result that it came out of the bath as true as when it was taken from the lathe.

In making the blanking die *B* it was bored from the back so that the hole was about .004 inch smaller at the cutting edge than at the back. The die bed *A*, of cast iron, was bored out to receive this die and after it had been inserted three holes were drilled and tapped, half in the die and half in the bolster, as shown at *E*. In these were fitted three screws to keep the die in place. This die was hardened with the same care that was exercised in hardening the punch. The next step was to make the tool steel bushing *D*, which slides between the forming and the blanking dies. The parts of the die were then assembled and two holes for the screws *GG* were drilled and tapped from the back of the die bed into the forming punch *C*, which was then ready to be hardened. *FF* represent two of the steel pins which press against the bushing *D*, and *I* is a soft rubber bolster by which the pins are held up in place.

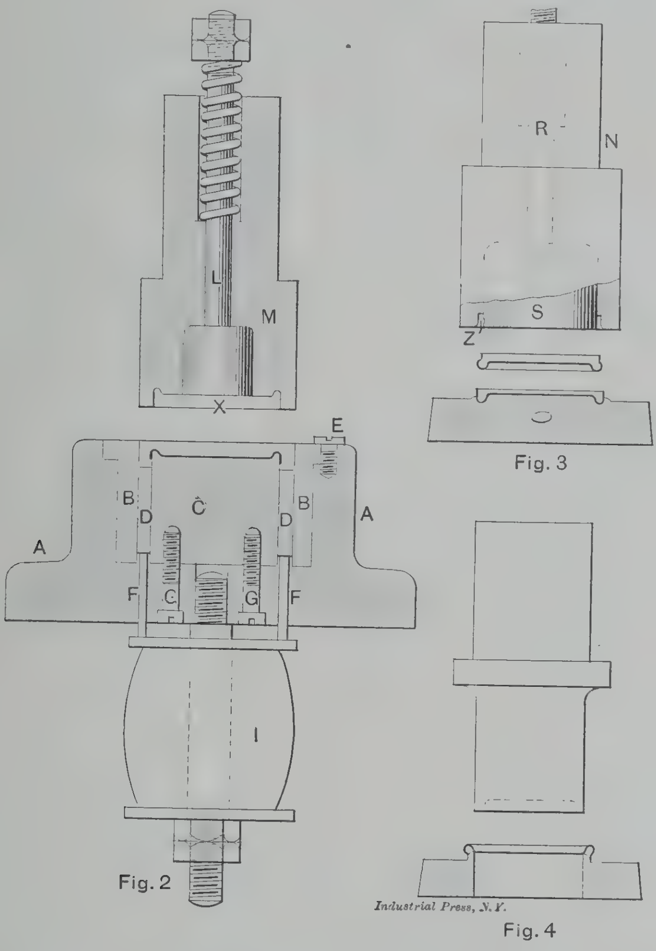


Fig. 2

Fig. 3

Fig. 4

Industrial Press, N.Y.

Punches and Dies for making Lens Rings.

The die operates in the following manner: The blanking punch *M*, entering the die *B*, cuts out the blank to the proper diameter. As the punch travels downward it bends the blank over the forming die *C* and, coming to a stop, it forms the ring shown at *A*, Fig. 1. When the punch ascends, the bushing *D*, having compressed the rubber bolster, strips the blank off from the forming die *C* and the punch carries it upward until the knock-out strikes the knock-out arm in the press at the end of the upward stroke. As the press is tilted, the blank then drops clear of the die, into a box.

Fig. 3 shows the punch and die used for reducing the diameter of the punching, as shown at *B*, Fig. 1. The die *O* is turned out on its face to receive the blanks, one of which is shown in the position in which it is placed ready for the punching. In the punch, the recess *Z* is bored to the required diameter and the hole and recess for the knock-out and knock-out stem, *S* and *R*, are also bored at the same setting. The recess *Z* is beveled off slightly to locate the punching. The action of this punch is similar to that for performing the first operation. The punching is carried upward until the knock-out strips it from the punch and the tilted press allows it to drop into a box. Between the punch and die is shown one of the pieces as it is ejected from the punch. Fig. 4 shows the tools that are used for blanking out the bottom, leaving the work in the shape of a ring shown at *C*, Fig. 1. Before the bottom is blanked out, however, the ring is reduced considerably at its rim as at *L*. This is done in a monitor lathe, the punchings being mounted on a spring collet and an ordinary cut-off tool being used. The reduced part is afterward bezzeled over a lens.

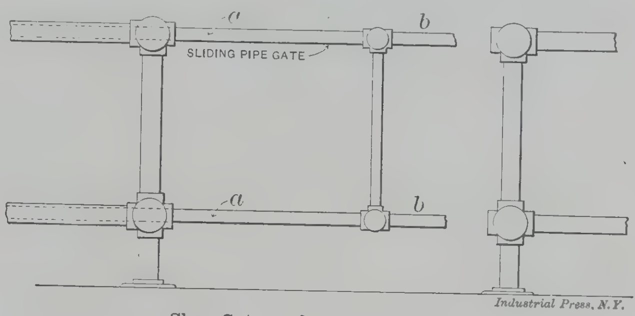
FRANK GREINER.

New York City.

SIMPLE SLIDING GATE FOR MACHINE SHOP.

Editor MACHINERY:

At the new shops of the American Turret Lathe Co., Warren, Pa., recently visited by the writer, a simple sliding gate for the gallery was observed which is made entirely of pipe and pipe fittings, and which utilizes the adjacent pipe railing for guides. As it appeared to serve its purpose fairly well, a sketch is given herewith which makes the construction understood with little explanation. The gate is, of course, made of a size of pipe smaller than the adjacent pipe sections constituting the gallery railing so that the ends *a a* can slide freely within them. The ends *b b* also slide into the opposite pipe ends of the opening when the gate is closed.



Industrial Press, N.Y.

Shop Gate made of Pipe Fittings.

F. EMERSON.

* * *

In a paper on radium and other radio-active substances read by William J. Hammer before an extra meeting of the American Institute of Electrical Engineers, April 17, some interesting facts regarding radium and selenium were discussed. It has been demonstrated by the Curies that radium at all times maintains a temperature of 1.5 degrees C. (2.7 degrees F.) above its surroundings. A half-pound of radium salt is estimated to evolve as much heat in one hour as the burning of one-third cubic foot of hydrogen gas, and the heat radiating from pure radium would melt more than its own weight of ice every hour. Mr. Hammer has recently received a notification from the Société Centrale that they will shortly put pure radium on the market at a cost of 30,000 francs per gramme or about $2,721,555.90 per pound. The enormous cost is due to the great difficulty of separating radium from the uranium residues from which it is separated, it being necessary to handle 5,000 tons of the residue to obtain 2.2 pounds of radium. In regard to selenium the author referred to an interesting and valuable application of selenium to regulating the light emitted by Pintsch gas buoys, which are anchored at the mouths of bays and rivers to mark the entrance, etc. Heretofore it has been necessary to let the gas burn night and day because of the impracticability of any ordinary apparatus designed to shut it off during the daylight hours. A selenium cell, which is highly sensitive to light in the matter of electrical conductivity, gives a practicable means for turning the gas on and off so that it is only consumed during darkness. In this way it will be possible to make the gas of a Pintsch buoy which now lasts only a month, last two or three times as long.

A GEARED VARIABLE SPEED MECHANISM.

FRED S. ENGLISH.

At the present time there seems to be, among machine tool and automobile designers, a tendency for a geared variable speed transmitter, capable of a wide range of speed coupled with an almost instantaneous change without stopping the machine. This has already been accomplished in various ways, several of which might be enumerated with their good points and faults, would space permit. The scheme which I am about to describe for accomplishing this is more elaborate and probably more expensive than any the writer has seen, but to offset this objection the method of operation is extremely simple; the operator simply pulls a rope and the machine automatically shifts one notch, with no shock, and locks itself in the new position. It can easily be arranged with a positive reverse and backing motion for an automobile.

The fundamental idea of the device consists in driving from a cone of gears to a sliding gear through a series of free running intermediates so placed that the faces next the sliding gear all come in line so that the gear is simply slid on the shaft without the necessity of moving on a swinging arm. Now, if when the machine is assembled the intermediate gears are arranged so that the teeth opposite the sliding gear all line up, they will always line up whenever the cone of gears comes into the same position again. In this position the sliding gear can be moved from one intermediate to the next by means of a cam, with no shock and no danger of breaking the teeth.

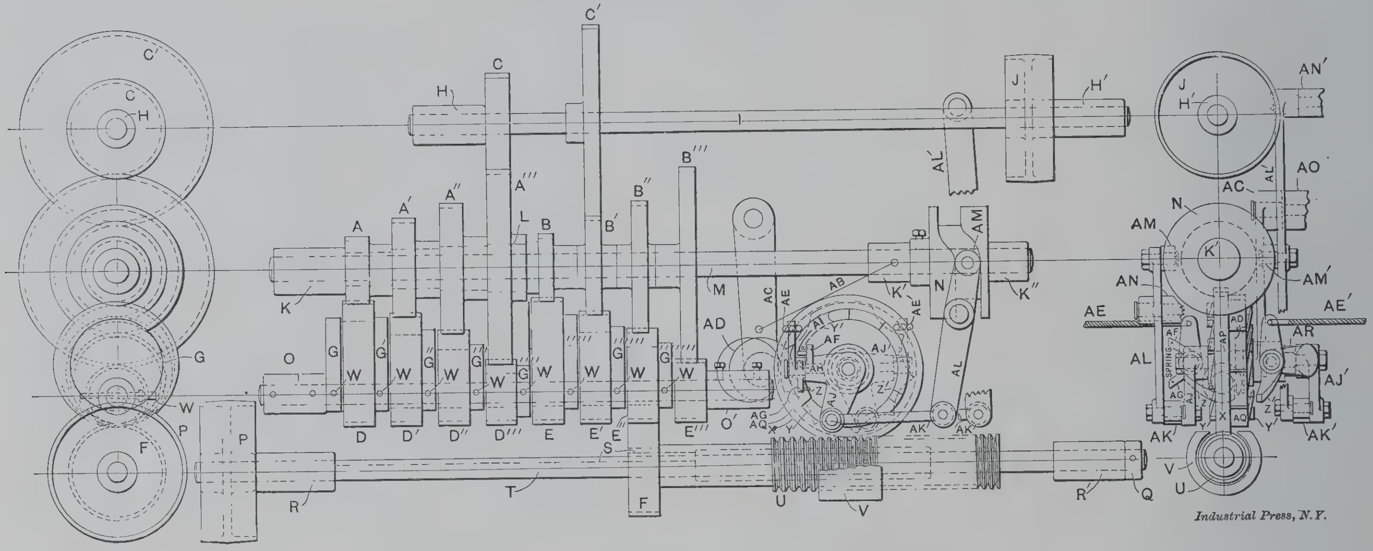


Fig. 2 Fig. 1 Fig. 3

Detail of Geared Variable Speed Mechanism.

Referring to the cuts, Fig. 1 is a plan of the machine, Fig. 2 is an end elevation, showing the layout of the gears while the other end elevation, Fig. 3, shows the cam and shifting mechanism. It will be noticed that the frame and housings are omitted, simply the bearings for shafting and levers being shown, as the drawings are not intended for a complete design but simply as a means of description. As will be seen in Fig. 1, we have eight different speeds with a reduction of twelve to one. Running loose on the shaft *M* is a quill *L*, which carries the cone of gears A, A', etc., while fast on the same shaft is another cone of gears B, B', etc. These gears and shaft are driven from the main driving shaft *I* through the gears C, C'. This scheme of driving *A*, *B*., etc., from shaft *I* instead of putting the pulley *J* directly on shaft *M* is to keep gears B, B', etc., from becoming excessively large, and could easily be omitted if the range of speeds was not over six or eight to one. Fast in bearings O, O', is a shaft carrying eccentrics G, G', etc., collars of which are pinned to the shaft with the taper pins *W*, *W*, and may be braced from the frame if thought necessary. Running free on the collars are the intermediate gears *D*, *E*, etc. Sliding on a feather *S*, on shaft *T*, is a quill having rack teeth *U* cut in its circumference, and carrying gear *F*. The ends of the teeth on gears *D*, *E*, *F*, etc., are tapered off (see Fig. 5) to give an easy entrance for the sliding gear. Shaft *T* carries the pulley *P* which drives the mechanism in question.

Free on a stud and meshing in the rack teeth *U* is a gear *X* and made integral with this gear on the top is a ratchet *Y*, while on the bottom is a plate *AQ* having a series of notches in its circumference and under this another ratchet Y' with its teeth pointing in the opposite direction from those in *Y*. Swinging on the same stud as the gear are the bell cranks *A J* and $A\ J'$ carrying pawls Z, Z'. These pawls are normally held out of contact with the ratchets by means of a spring between *A G* and *A F*, the stop *A H* resting against *A I*, (this is not shown on pawl Z';) either pawl is placed in action, when required, by pulling the rope *A E* or $A\ E'$, one rope moving the sliding gear in one direction and the other moving it in the other direction. Lever *A C*, swinging about a stud in *A O* carries the roll *A D*; this is held against the notched plate *A Q* by means of a spring *A B* and serves to lock the gear *X*, and consequently sliding gear *F*, in any position. Bell cranks *A J*, $A\ J'$, are operated with the cam *N* through the levers *A L*, $A\ L'$.

Gears *A*, *B*, etc., are keyed in such a position that the teeth in the intermediate *D*, *E*, etc., opposite gear *F* are all in line so that *F* may be slid easily from *D* to E'''. Place the gear *F* half way between any two intermediates and the gear *X* in such a position that the roll *A D* comes exactly half way between the two notches corresponding to the position of *F*. Set the cam *N* so that the lever *A L* has moved to mid position. Pull the pawl *Z* into action and turn the shaft *M* around until the still run of cam is reached and gear *F* will have moved fully into gear with the intermediate at the right. When the shaft has made a half revolution the intermediates *D*, *E*, etc., are again in line (provided the number of teeth in gears A, A', etc., are divisible by eight and those of B, B', etc., are divisible by two), and the cam is moving the bell crank $A\ J'$. Now, if the pawl is in action, gear *F* will be moved to the left. It is seen that each bell crank is moved forward and back every revolution of *M* and at just the proper time to slide gear *F*, but that the gear does not slide except when the one or the other of the pawls is pulled into action.

When the gear has been moved to one end or the other of its throw it cannot be moved out of gear, no matter how much the rope is pulled, if the remaining teeth are cut off the ratchet. By continuing to pull one cord the speed can be changed from one extreme to the other during seven revolutions of shaft *M*, or during about six revolutions of shaft *T*, depending on the ratio of the gears.

Fig. 4 shows the cam developed, and Fig. 5 shows various positions of gears E'', E''' and *F* (looking directly down on the tops of the teeth), while the cam moves from *B D* to *B C*; it is seen that the gear *F* begins to move some time before E'' and E''' are in line and that they are not exactly in line until *F* is half way across. The first position is with the cam roll at *B D* while E''' is one-quarter of a tooth behind E'' and *F* just passing by the ends of tooth E'', in the second position E'' has moved one-quarter of a tooth and E''' three-eighths of a tooth, making E''' only one-eighth of a tooth behind *E''*; in the third position *E''* has moved one-half of a tooth and *E'''* three-quarters of a tooth making *E''* and *E'''* exactly in line while *F* is just half way across; in the fifth position *E''* has moved one tooth and *E'''* one and one-half teeth, making *E'''* one-quarter of a tooth ahead of *E''*, while *F* is just leaving *E'''* and being driven entirely by *E''*.

An indicator moved by gear *F* should be placed on the outside of the frame (in case the gears are inclosed) to show the operator the exact position of gears. A better action could be obtained to the pawl by making the ratchet teeth parallel to the teeth of gear *X*. They were made as shown for constructive reasons, it being easier to cut the teeth of ratchet in this position, and it also requires a less number of sheaves to bring the rope into a convenient position. The ropes should be provided with balls at the bottom for pulling easily and also with a guard to prevent them from swinging in an arc with the bell cranks. *V* is a bearing for the quill rack that keeps it from springing out of mesh and makes it possible to have shaft *T* lighter than would otherwise be required.

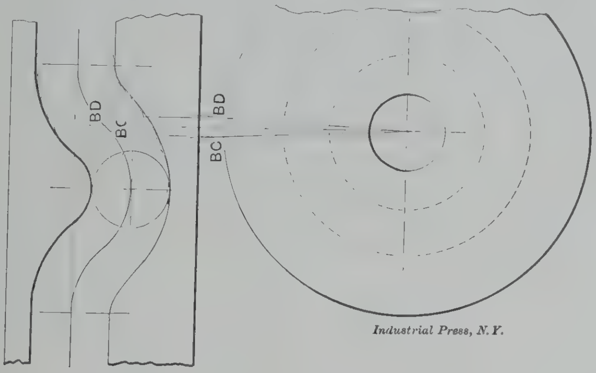


Fig. 4. The Cam and its Development.

For an engine lathe the pulley *J* should be replaced by the usual reverse pulleys and clutch or with tight and loose pulleys as required. Suppose it is required to make a positive reverse and backing motion, say for an automobile. Turn the cone of gears *A*, *A'*, etc., end for end and drive them in a reverse direction by means of an intermediate between *C* and *A'''*; spread intermediates at *D'''* and *E* far enough apart to put another gear similar to them between them and driven from either one by means of a spring key, which is thrown from *E* to *D'''* by motion of the gear *F*. To reverse, pull the rope moving *F* off from *E* onto the intermediate between *E* and *D'''*. By means of this motion the spring key can be moved from *E* to *D'''* and when the gears come into register the spring gear will drop into place reversing the gear *F*; pull the rope again and *F* moves on to *D'''* and so on to the fastest backing motion. The gearing can be so arranged as to make *E* and *D'''* revolve very slowly, thus making but little strain in reversing.

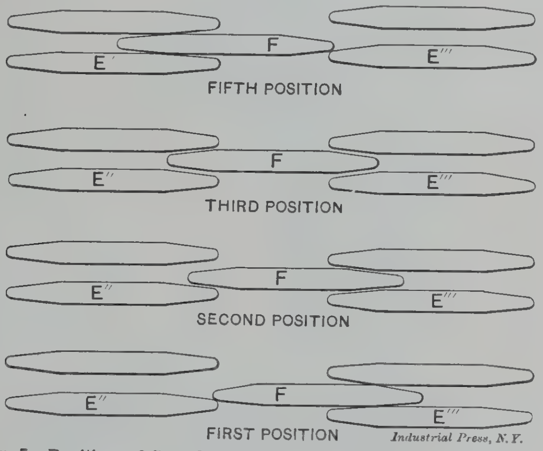


Fig. 5. Position of Gear Teeth during Portion of the Cam Throw.

* * *

The craze for high speed has resulted in some racing automobiles equipped with engines of extraordinary power. At a recent tournament at Nice, France, a machine was entered having a wheel base 9 feet 9 inches long and a four-cylinder gas engine of 110 horse power.

ITEMS OF MECHANICAL INTEREST.

MILLING CIRCULAR T-SLOTS–COMBINED DRILL DRIFT AND HAMMER–NEW TYPE OF MILLING MACHINE–STEAM STEERING GEAR–MAMMOTH TRACTION ENGINE.

The band saw which is now generally used in all up-to-date woodworking mills, probably puts tempered steel to the severest possible test. It runs like a belt over wheels of moderate diameter, under considerable tension and at high speed. Every time a section of the saw makes a complete circuit it is bent back and forth twice, and this takes place many times a minute, day after day for astonishingly long periods before the saw breaks. And then the practice is to mend the break by sweating together with silver solder and scarfing down the ends until the joint is of the same thickness as the body of the saw. How long a band saw can be run before it begins to break so often as to make it unprofitable to continue repairing it, we do not know. A comparatively recent innovation in band saw machinery, which puts the steel under still further duress, a combination of bending and twisting stresses—is a band cut-off saw. In this machine the saw is twisted one-fourth way round by guides just after leaving the wheels so as to present the teeth of the saw in a plane at right angles to the log.

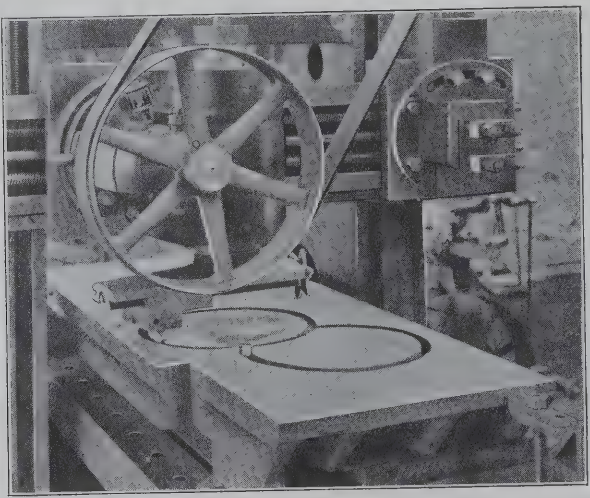
The operation of electric motors in a dust-laden atmosphere, especially that of a cement-grinding mill, is a problem that does not appear to be successfully solved by the use of the so-called "dust-proof" motors. A scheme tried in the Edison cement mills by which ordinary motors can be successfully used, consists of surrounding the motor with a light frame carrying a covering of porous textile material like gunny cloth, which acts as a dust sieve, but permits the air to pass through. To secure the necessary circulation of air to prevent heating of the motor, the air is drawn through the cloth covering and discharged at an opening by a small electric motor fan. The area of the casing is, of course, so proportioned that sufficient air is readily drawn through by the inductive action of a comparatively small fan, which is located within the casing and discharges through an opening in the side. To give a comparative idea of the size of the casing required, it may be mentioned that a five-horse power motor was incased in a frame four feet wide, four feet long and six feet high. This was covered with two thicknesses of cloth spaced two inches apart.

Mr. W. H. Booth, the well-known English writer on technical subjects, in a recent letter to the *Mechanical Engineer* discusses the errors that develop in limit gages of their (English) manufacture, and suggests the cause. He says that it does not appear possible to mechanically grind a gage to a guaranteed accuracy of 0.0001 inch, and consequently it is necessary to finish them by hand. In the hand-finishing process errors of parallelism are usually corrected by gentle pening on the sides or edges, thus putting the surface under tensional and compressive stresses. When a gage treated in this manner goes into the workshop, it maintains its accuracy until the varnish or japan on the body of the gage has worn away under the influence of the grimy, gritty hands of the workmen. The abrasion of the hand then soon wears away the surface particles, which at once permits a readjustment of the shape of the gage as the stresses are relieved. The result is, of course, an inaccurate gage with no apparent reason for such a condition. Mr. Booth then infers that adjustable gages of the type used by the Newall Company, are the best in the long run since the material is annealed and free from stress. This system of limit gages is considered less cumbersome and expensive than the solid type, and more accurate. The best makers of American gages grind them as closely as possible and then finish by lapping, no hammering or pening being allowed.

It so rarely happens that a steam boiler fails when subjected to the usual hydrostatic test by the builders, that the rupture of a large Scotch boiler under test at the Polson Iron Works, Toronto, Canada, is of considerable general interest, especially when the physical properties of the steel plates revealed by the accident, are known. The shell plates were of steel, having a tensile strength of 60,000 pounds per square inch, and were 1 1-32 inches thick. At the time of the test two pressure gages were attached to the boiler and both indicated a pressure of 270 pounds when without warning the shell cracked in the solid metal, from one end to the other. Examination of the plates showed them to be very brittle, and when attempts were made to straighten them under a hydraulic press, they broke cleanly like glass. A number of fine cracks were discovered in the plates about 3-16 inches deep that had been produced by rolling them into shape for the shell. The incident demonstrates anew that eternal vigilance is the price of safety in the construction of steam boilers, especially in the material used. Who knows how many mysterious boiler explosions have been caused by defective material rather than the carelessness of firemen and engineers?

MILLING CIRCULAR T-SLOTS WITH PLANER ATTACHMENTS.

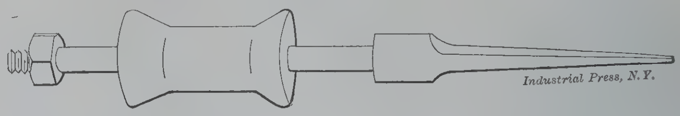
The half-tone herewith shows a method of cutting circular T-slots, that is employed at the shops of the Adams Co., at Dubuque. The castings, in which the slots are cut are quite large, weighing about 1,000 pounds, so that any method of machining that will save handling is of decided advantage. The plate is set on the platen of an ordinary planer and the top planed off in the regular way, using a tool in the planer head. The T-slots are then bored out by using the traverse head in connection with a Farwell milling attachment. The tools for this are placed in the sliding portion of the traversing head and are fed radially by the star at the other end. The vertical feed is obtained by lowering the cross rail. There will be no trouble in giving the miller an accurate vertical feed, by raising and lowering the rail, if care is taken not to loosen it too much from the housings. The rail should be just tight enough to prevent it from falling by its own weight which will allow the screws, instead of gravity, to impart the feed. As soon as one of the slots has been bored, the platen of the table is run forward and the milling head set across the cross rail until the work is brought into position for the second hole which is then milled exactly as the first. The entire work on the piece is thus accomplished with a single setting.



Planing Plate and Milling T-Slots at one Operation.

A COMBINED DRILL DRIFT AND HAMMER.

Although a drift for removing drills from the drill socket is usually to be found chained to the drill press, so as to be always handy, any one who has had much experience in drilling has often realized that but one-half of the purpose is accomplished, for as soon as the drift is inserted in the hole the machinist must hunt about for a hammer with which to drive it. The hunting part of the operation generally occupies more time than the actual removal of the drill so it has occurred to some one to combine with the drift a device for pounding the same so that the use of the hammer will be unnecessary. This device, as shown in the cut, consists of a regular drill drift at the end of which is a cylindrical shank. Sliding on this shank is a heavy iron spool which is retained by a nut on the outer end. When a drill is to be removed the drift is inserted in the usual way, the spool pulled back on the shank and then pushed briskly forward against the head of the drift, thereby producing a sharp blow which drives the drill from its socket. In the end of the shank, where it projects from the nut, there is a drilled hole by which the drift can be chained to any convenient point on the drill press. This drift is manufactured by the Maria Stein Machine Works, Maria Stein, Ohio.



Combined Drill Drift and Hammer.

AN INTERESTING MILLING MACHINE.

In the May number of MACHINERY there was published a description of a grinding machine employing the sun-and-planet motion by which the grinding spindle is made to describe a circle as it grinds the interior of a hole. This style of machine is employed in grinding holes in work that is too large or not suitably shaped to allow it to be rotated. The same principle has been applied by Mr. Eric Johnson, of the Seattle Machine Works, to the milling machine which is illustrated by the accompanying photograph and drawing. This machine, as originally designed, was intended for milling circular recesses in the rims of a variety of circular saws but it is equally applicable to all kinds of milling where it is necessary for the work to remain stationary while the cutter describes the circle being cut.

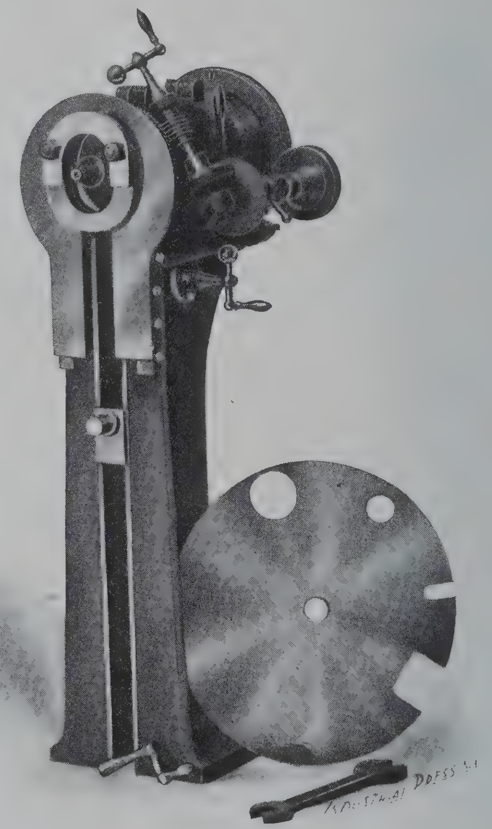
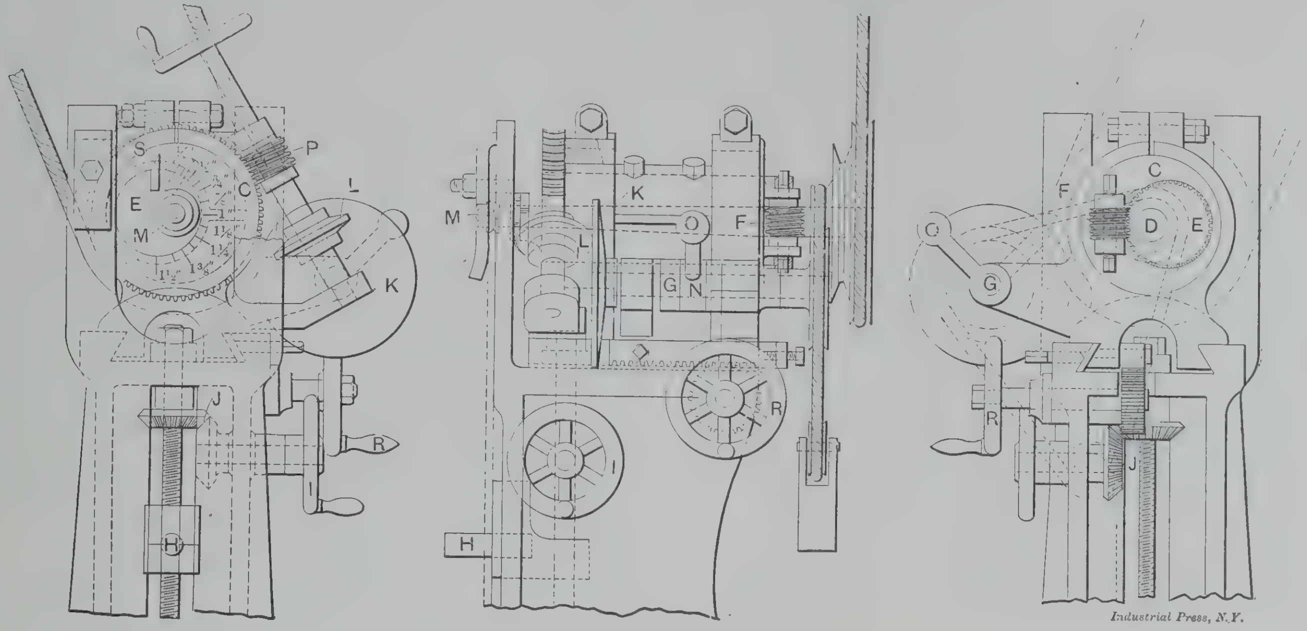


Fig. 1. A New Type of Milling Machine.

At the foot of the machine shown in the photograph, will be seen one of the saws that has been milled with several holes and slots showing the class of work of which the machine is capable. The saw to be milled is mounted on the pin *H* which has a vertical adjustment, by means of the handwheel *I* and the miter gears *J*, to accommodate saws of any diameter within the capacity of the machine. For general use this pin would be replaced by an elevating table on which the work would be held. The milling cutter *M* is carried on a spindle *D* which runs in an eccentric hole in the sleeve *E*. This sleeve, in turn is carried in another eccentric sleeve *C* which is free to rotate in the head of the milling machine. Upon the back of the sleeve *E* is a worm wheel which is operated by the worm *F*, mounted on the end of the sleeve *C*. Turning this worm, by means of a wrench applied to the flats on the end of the worm shaft, will therefore cause the inner sleeve to turn within the outer, and as the eccentricity of the shaft in the inner sleeve is equal to that of the inner sleeve in the outer it will be seen that it is possible to bring the shaft concentric with the outer sleeve or to off-set it so that during a revolution of the outer sleeve it will travel in a circle whose diameter is equal to the combined eccentricity of the two sleeves. A pointer *S* upon the sleeve *E* indicates the amount of eccentricity as shown by the graduations on the sleeve *C*.



Industrial Press, N.Y.

Fig. 2. Details of Special Milling Machine.

The cutter itself is driven by a rope running over a grooved pulley which is keyed directly to the spindle. From another sheave on this pulley a rope passes over a sheave on the end of the shaft *G*, while a counterweight provides for the difference in distances between the spindle and the shaft *G*, due to the spindle moving about a center while the shaft *G* remains stationary. Upon the forward end of this shaft is the friction disk *K* which, by means of a cam and lever *N* and *O* may be forced into or thrown out of engagement with the friction wheel *L*. The shaft on which this friction wheel is mounted carries a worm *P* which meshes with a worm wheel on the front end of the sleeve *C* and causes it to revolve in the head of the machine, thus causing the spindle to describe a circle of the required diameter. The head itself is dovetailed to the column of the machine and may be fed forward or back by means of a rack and pinion operated by the hand wheel *R*.

STEAM STEERING GEAR FOR U. S. TORPEDO BOATS.

The accompanying cuts show a simple type of steering engines and gear used on some of the government torpedo boats, the particular engines illustrated being used on a boat built at the yards of the Fore River Engine Co., Quincy, Mass. At the center of the crank shaft of the engines is a worm which drives the rack, Fig. 1, through a worm wheel and pinion. This rack gives motion to the rudder. There are two engines operating on the same shaft and between their cylinders is the controlling valve, which is moved up or down to start the engines in one direction or the other. The valve is moved by a lever actuated by a nut on a threaded section of the tall vertical shaft at the front of the engines. The problem is to have this valve so operated that when the steering wheel is turned in one direction a definite amount, the rudder will be turned by the engines in a corresponding direction, and also a definite amount, depending on the distance the steering wheel is moved. In any steam steering gear the interesting portion of the mechanism is that part connecting or regulating the relative motions of the steering wheel, the rudder and the engines. When the steering wheel is moved, the engines must start, which in turn moves the rudder; and when the rudder has reached the desired point its motion must act upon the engine valve to stop the motion of the engines.

The essential features of this mechanism of the engines under consideration are indicated in the diagram in Fig. 2, and the most important parts of this diagram are the steering wheel *A*, the vertical shaft *B*, the nut *C* on the threaded portion at the lower end of the shaft, and the connections; first, between this nut and the engine valve, by means of the lever *D;* and second the rack *R* by means of the gears *E* and *F*.

When the steering wheel is moved, the shaft *B* turns, and as the nut *C* is kept from rotating by its geared connection with the rack *R*, it screws up or down on the shaft *B* according to the direction in which the latter rotates. This vertical movement of the nut *C* actuates the engine valve by means of lever *D*, whereupon the engine starts and slides rack *R* one way or the other and so moves the rudder. As soon as the rack moves, nut *C* begins to turn, being driven through

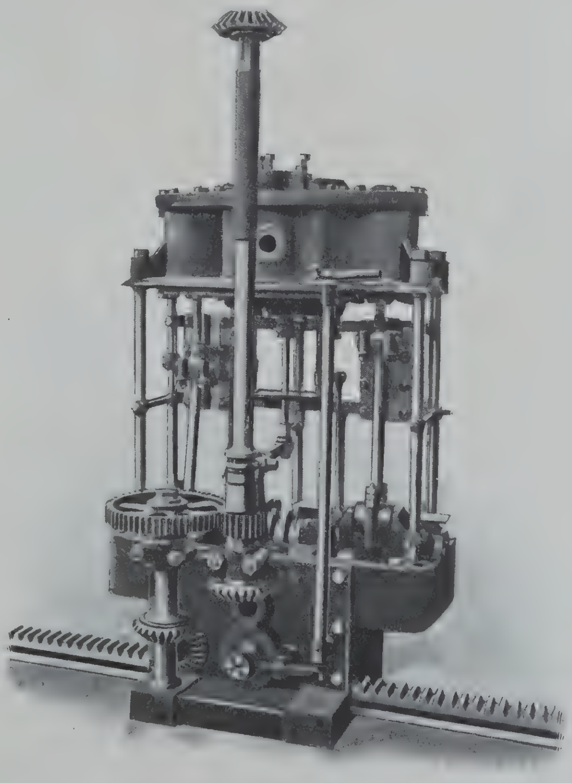
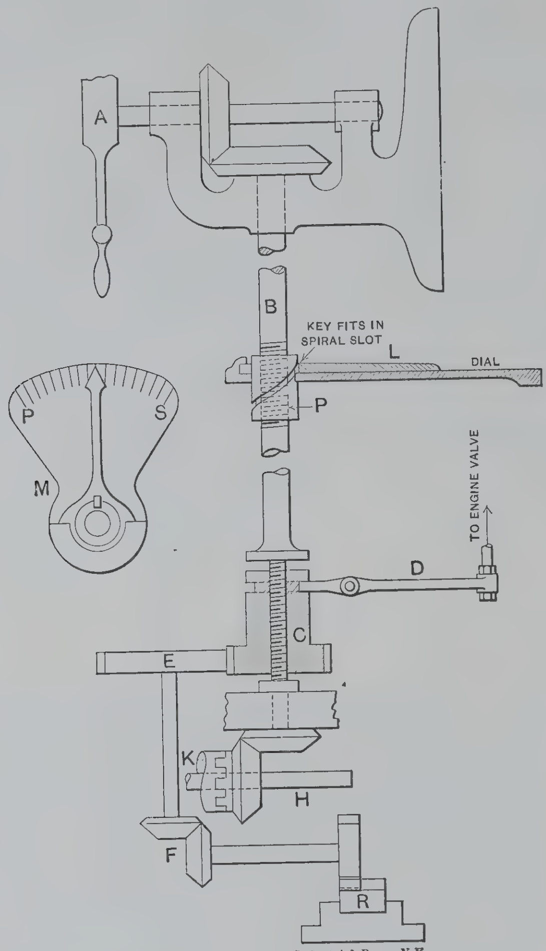


Fig. 1. Steam Steering Gear.

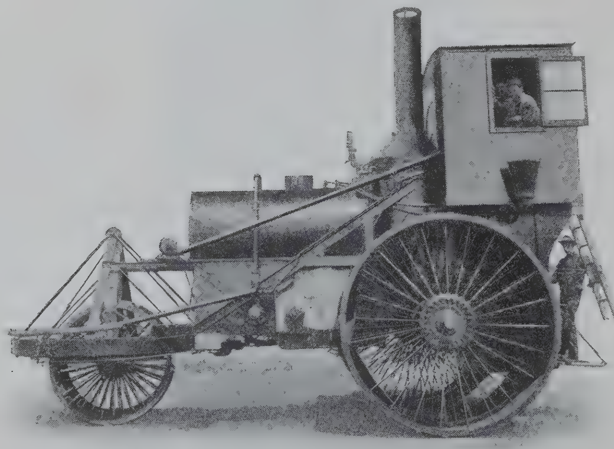
gears *F* and *E*, and screws back to its central position, closing the engine valve. This of course stops the engine, and the distance that the rudder has moved is gaged by the distance nut *C* has been raised or lowered by the motion of the steering wheel *A*. It will be seen that the function of the nut *C* is the same as that of a floating lever, the rising or lowering of the nut being in effect the same as the tilting action of a lever.



Industrial Press, N.Y.

Fig. 2. Diagram of Steam Steering Gear.

The steering wheel *A* is located in the pilot house of the vessel and connection may also be had with a wheel on the bridge by means of gears *H* at the lower end of shaft *B*, this connection being thrown in or out by the clutch *K*.



110 H. P. Traction Engine.

With any steering arrangement it is necessary to have some way of knowing what the position of the rudder is at any time, and this is here accomplished by the pointer or indicator *L*, also shown in plan at *M*. On a threaded section at the upper end of shaft *B* is a nut *P*, on the outside of which is cut a spiral groove. The pointer fits over the outside of the nut, and a key is fitted to the spiral groove and also to a spline in the pointer. The nut cannot turn but moves up and down with the motion of the shaft and the spiral groove causes the pointer to indicate the position of the mechanism and hence the position of the rudder, to port or starboard.

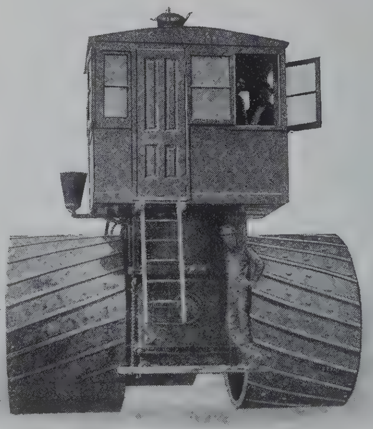
MAMMOTH TRACTION ENGINE.

The development of the traction engine for hauling purposes, has reached an advanced state in the far West, especially in California where it is largely used for drawing trains of wagons in place of mule teams. The relative cost of freighting by traction engines and mule teams, is said to be about as 1 to 2. It is not unusual for the larger traction engines of, say 50 H. P. to haul loads of 20 to 25 tons at the rate of 3 to 4 miles per hour, and on grades of 12 to 15 per cent. they will handle from 75 to 80 per cent. of the above loads. One striking feature of these western traction engines is their very large and broad driving wheels, 7 feet diameter and 2 feet width of tire being common. The steam pressure is high, being from 125 to 150 pounds.

The accompanying illustrations show side and rear views of a heavy high-powered traction engine, being a 110 H. P. three-wheeled engine built by the Best Manufacturing Company for the Middle River Farming Company. The steering wheel is 5 feet diameter and the width of the tire is 14 inches. The rear driving wheels are 8 feet diameter and the tire widths 26 inches. The total width of the engine is 9 feet 7 inches and the weight is 31,000 pounds. The hauling capacity is equal to that of 50 horses which means that it can draw loads of 50 to 65 tons exclusive of the weight of the wagons. The boiler is a combination vertical and horizontal and can safely carry a pressure of 150 pounds. The obvious advantage of a vertical boiler is that when working on grades, there is no danger of the crown sheet being uncovered if the normal water level is maintained.

It will be noticed that the cab is tightly constructed and that there is a small fan blower in front of the water tank with its discharge pipe connected to the cab. This construction was necessary for the engine shown, as it was made for plowing on an island having a very soft, light, ashy soil. The dust rises in such great clouds when the engine is pulling the plows that it is impossible for the engineer to breathe, let alone seeing ahead from his position on the engine. Hence it was necessary to overcome this difficulty by building the cab tight like a house, with openings near the roof so that when the dust penetrates it the blower can be set in operation to furnish fresh air and to blow the dust out.

Fuel oil is used for this engine, the oil tank showing in the rear view just above the firebox. When using coal or wood a small supply is stored in the space occupied by the oil tank, and a larger supply carried on a tender. While the traction engine is scarcely a thing of beauty, it has proved to be a most valuable and indispensable factor in conducting large enterprises of the West, especially in regions remote from the railways.



Traction Engine (Rear).

* * *

The nickel-steel alloy having the least coefficient of expansion (about one-thirteenth that of wrought iron) to which we have referred several times, is patented. In England it is sold under the trade name of "invar."

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

26.—Will you kindly tell me what features the Engineering Edition of MACHINERY has, not included in the shop edition, that would be of benefit to the ordinary machinist? 2.—Will you or some of your readers give details of a boring attachment to go on the head of a planer? If this is to be driven by rope drive I would like details of that also. 3.—Also details of attachments for a lathe for internal and external grinding of reamers, cutters, etc.

A.—The Engineering Edition contains a summary or condensed report of the leading articles upon mechanical subjects that have appeared in other publications, thus giving a reader of MACHINERY information upon important topics discussed in various journals which he probably would not subscribe for or even see at all. To show how much valuable material appears in this department we will mention the subjects of a few articles reviewed in the last number of the paper. Among these were: The application of reversing motors to planers; the construction of concrete chimneys; description of the new Curtis steam turbine, which is now manufactured by the General Electric Company; description of a new type of German boiler in which a water tube boiler is combined with an internally-fired boiler; description of an English grinding machine operating on a new principle; reports of tests on the Banki motor—a German gasoline motor which operates on a new principle enabling very high economy to be secured; report on the performance of water-tube boilers in the government boat *Marietta*, this being the first thorough trial of marine water-tube boilers in which unbiased results could be made public; and finally the results of tests by Geo. H. Barrus, the consulting engineer, to show whether reheating receivers in compound engines are really of value—a disputed question among engine builders. All of these subjects are live topics, and important ones, and any machinist who is trying to keep in touch with things will be interested in them. In addition to this review the Engineering Edition contains several articles not found in the shop edition, some upon machine design —good to file away for reference—and some of a descriptive nature telling about machinery of general character aside from machine shop tools—steam engines, for example. What is considered by many of the greatest value, however, is the monthly data sheet given with the Engineering Edition, in which are tables, diagrams and condensed data relating to shop work and machine design. 2.—We will refer this question to our readers and also suggest that you write the Adams Co., Dubuque, Ia., who manufacture a milling attachment for planers. 3.—If you will consult our advertising columns under the head of manufacturers of "center grinders" you will find several attachments mentioned suitable for cutter grinding in the lathe. You can probably purchase these cheaper than you could make an attachment yourself.

27.—S. T. E.—Will you kindly explain the term horse power as applied to a steam boiler? Does it mean the same as when applied to an engine, and how is it determined?

A.—The term horse power as applied to an engine represents the capacity of the engine to perform a given number of foot-pounds of work, 33,000 foot-pounds per minute being taken as the standard horse power. This is determined by the formula:

$$H. P. = P \times L \times A \times N \div 33{,}000$$

in which

P = mean effective pressure, in pounds per square inch, acting on the piston.

L = length of stroke in feet.

A = area of piston in square inches.

N = number of strokes per minute = twice the number of revolutions per minute.

In a boiler the work is that of converting water into steam and cannot, therefore, be expressed in foot-pounds of available energy, so the standard of measurement usually adopted is the capacity of the boiler to evaporate a number of pounds of water of a temperature of 100 degrees F. into steam at a pressure of 70 pounds above that of the atmosphere. The evaporation of 30 pounds per hour under these conditions is called a boiler horse power as it is considered that this is the average requirement per indicated horse power of the engine. The horse power of a boiler depends directly upon the heating surface, but can be made to vary over a wide range by variations in the draft or in the method of firing. In designing a boiler it is generally customary to allow 12 square feet of heating surface per horse power, but this amount varies considerably with different builders. A very good rule for finding the approximate horse power of a tubular or water tube boiler is:

$$H. P. = N \times L \div 50.$$

in which

N = number of tubes.

L = Length of tubes in feet.

28.—O. H.—In making the pattern for a sprocket wheel, I have made use of the formulas given in Brown & Sharpe's catalogue for determining the outside, bottom and pitch diameters. These are, of course, correct, but I would like to inquire if some one has not a simpler method or formulas by which these dimensions can be determined.

A.—The formulas above referred to are the simplest that we know for determining the diameters for making sprocket wheels. If any of our readers can contribute any others or describe a graphic method for obtaining the same results, we should be pleased to receive the information.

29.—H. T.—How can I estimate the H. P. of a steam turbine, or figure out the indicated horse power. 2.—Are there any books on steam turbines showing different designs and data regarding the relative economy of turbines and reciprocating engines?

A.—The horse power of a steam turbine can be determined only by using a prony brake to measure the power; or, if the turbine is direct-connected to a generator, as is usually the case, by reading the ammeter and voltmeter on the switchboard. There can be no such thing as the "indicated power" of a turbine. The term applies to the power of a motor as determined by the steam engine indicator. An indicator cannot be applied to a steam turbine. The object of an indicator is to trace a line which shall show the pressure within the cylinder at every point in the stroke of an engine. In a turbine, of course, there is no cylinder and no means of determining what corresponds to the indicated horse power. 2.—We will refer you to "The Steam Turbine," by R. M. Neilson, and published by Longmans, Green & Co.; price $2.50.

* * *

A recent call at the Lehigh Valley R. R. shops at Easton, Pa., revealed some interesting locomotive tire turning work, which is, we think, far ahead of what is being accomplished in most railroad shops that are attempting increased product in this line. Locomotive driver tires are turned in a 90-inch Pond lathe at a cutting speed of 20 feet per minute, using tools made of Novo and Midvale steels. At the time of our visit one tool rest carried a Novo tool and the other was one made of Midvale steel. The difference in the work and durability of the two tools, is said to be practically inappreciable. A pair of 56-inch tires are turned complete in about three and one-half hours, or three pairs in something more than a day's work. A recent record showing rapid work, is the turning of the tires of a six-wheel-connected engine that went onto the drop-pit at one o'clock in the afternoon. The wheels were dropped and the tires turned, two new wedges put in and some other minor repairs made. The engine was ready to go out the next day at noon. Of course the wheel lathe ran all night, but the tires were turned the next morning at six o'clock.

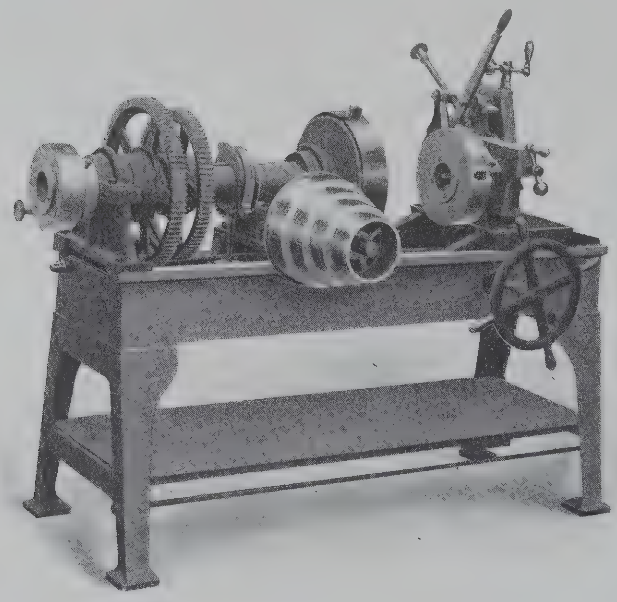
Tires were being bored on a Niles boring mill working at a cutting speed of about 32 feet per minute, roughing cut, and 50 feet finishing cut. They have run finishing cuts as high as 80 feet per minute. This is very high speed when the hardness of locomotive tires is considered. The ordinary roughing cut is ¼ inch and 3-16 inch feed. The three sizes, 56-inch, 62-inch and 70-inch tires are all bored in the same time, or 1 hour 20 minutes, no change of the belt on the cone pulley being made for the three sizes of tires.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

PIPE CUTTING-OFF AND THREADING MACHINE.

The half-tone presented herewith illustrates the "Peerless" special improved pipe machine, for cutting off and threading pipe, that has recently been placed on the market by the Bignall & Keeler Mfg. Co., Edwardsville, Ill. This machine combines simplicity of design with good proportion and accurate fitting of its parts which are so designed as to occupy a minimum amount of floor space. This machine, as regularly constructed, is driven from a cone placed parallel with the spindle, but when it is desired to secure a minimum amount of floor space occupied the cone may be mounted, as shown in the illustration, at right angles to the spindle. The capacity of this machine is from ¼-inch to 2-inch pipe inclusive, and it is furnished with a complete set of dies, eight in all, for cutting each size of pipe within this range. Each set of dies consists of four chasers which are regulated in the die head by the "Peerless" die adjustment.



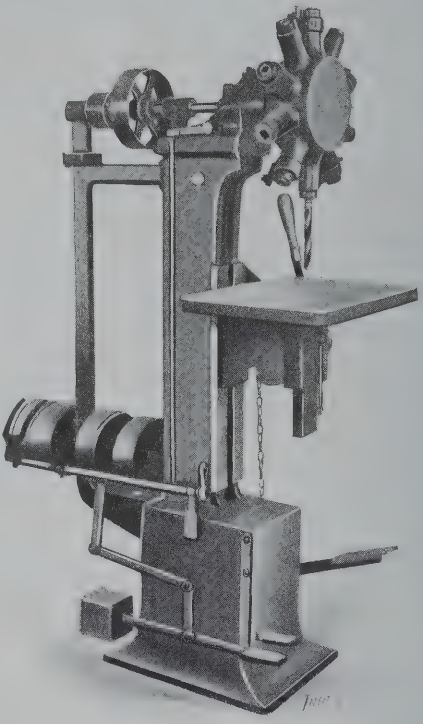
"Peerless" Threading and Cutting-off Machine.

The pipe to be threaded is securely gripped by a universal chuck in the front and held parallel by a scroll chuck on the rear. As both chucks are self-centering, accuracy and quickness in chucking is secured. The machine is furnished with an automatic oil feed arrangement whereby the oil is supplied to the dies and cutting-off tools and then returned to the bed of the machine. Cut gears are used throughout thereby insuring easy and noiseless running that cannot be obtained where cast gears are employed.

TEN-SPINDLE TURRET DRILL.

The A. E. Quint Co., Hartford, Conn., have just added to their line of turret drills the ten-spindle drill illustrated herewith. This machine is designed for light jig drilling where it is desirable to use several sizes of drills upon the work without removing it from the jig. The drill is so constructed that the feed of the work to the tool, the indexing of the turret head and the change of speed are all performed by the use of foot levers, leaving the operator's hands free to handle the jig or the work. Only the spindle pointing down to the center of the table rotates, and as all spindles, when indexed, point to same center the pressure of tool at work is at all times in center of table. Any spindle may be thrown into or out of action without stopping drill by means of the center foot lever which will release the turret locking pin. When the turret head is revolved to the spindle wanted the pin locks the head before the spindle rotates.

The two speed changing device consists of two friction pulleys on countershaft fastened to back side of the drill with a friction clutch between them, the clutch being held in contact with one of the pulleys by means of a weight, shown on end of foot lever. When necessary to change the speed of drill the foot is pressed on lever; this raises the weight and moves the clutch from one pulley to the other, then the flat spring on front side of base springs over top of lever and holds the clutch in contact with pulley. When the size of tools used demands more than two speeds, an overhead two speed countershaft may be used. Belted to countershaft on drill this will give four drilling speeds. The table is 14 inches by 20 inches; the distance from face of column to center of spindle 8¼ inches, while the greatest distance from the table to the spindle is 20 inches.



Ten-spindle Turret Drill.

THE "HERO" EMERY GRINDER WITH DRILL GRINDING ATTACHMENT.

Figs. 1 and 2 illustrate a very convenient little emery grinder that has lately been placed on the market by the Robertson Mfg. Co., Buffalo, N. Y. It is designed for use in repair shops, blacksmiths' shops or in any place where power is not available. It will also prove convenient in the large shops where, at times, a grinder is needed when the power is not in operation. The shaft runs on ball bearings and carries two solid emery wheels 6 inches in diameter and ¾ inch wide.

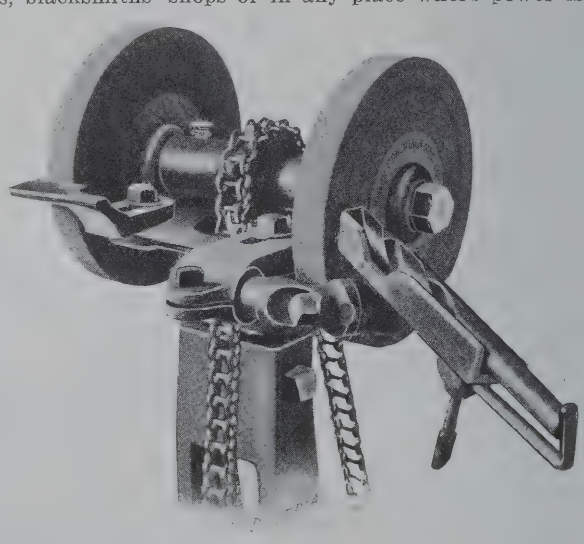


Fig. 1. Twist Drill Grinding Attachment.

The spindle is driven by a chain running over a large driving wheel, which is operated by a crank and foot lever. The head is provided with the ordinary grinding rests and special holders are made for knife and skate grinding. The twist drill grinder, shown in Fig. 1, can be readily attached in place of one of the regular grinding rests.

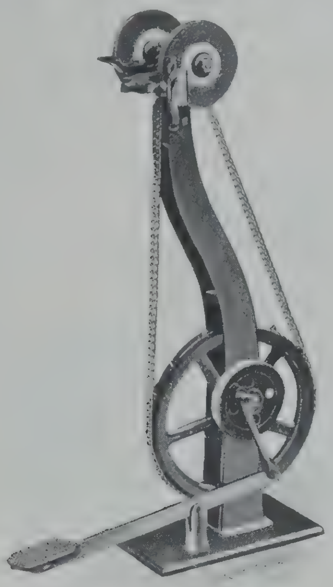
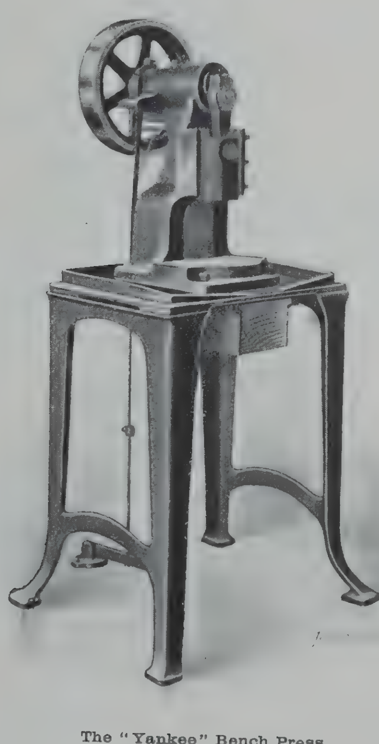


Fig. 2. "Hero" Foot Power Emery Grinder.

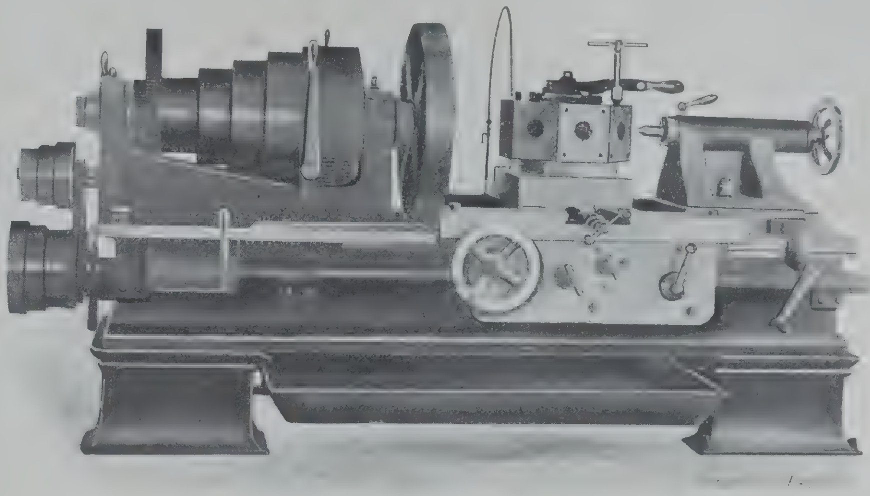
THE "YANKEE" BENCH PRESS.

The half-tone herewith illustrates a form of power press that was originally designed by Mr. Robert C. Manville for light blanking, piercing, clipping, forming and similar work which was formerly done in the ordinary foot and screw presses. The main features that were embodied in the original press are still retained in the new model with such improvements as time and experience have brought about. For the adjustment of the slide to accommodate the different heights of dies and lengths of punches, there is, in the connection, an eccentric bushing which slips onto the crank pin. By loosening this bushing, which is done by simply loosening the screw at the top of the connection, it may be turned so as to obtain any required height.



The "Yankee" Bench Press.

There is a variety of work that has to be placed in position by hand, and in order to do this the press must be brought to a stop at the end of each revolution. In order to make it practically safe for the operator there is provided a combination stop clutch which is so arranged as to render a second revolution of the press impossible without raising the foot. If a continuous motion is required, as with the ordinary power press, it can be obtained by throwing out a trip, which is done by simply turning a screw on the upper end of the treadle connection. These presses are made in two sizes, and may be used on the bench or mounted on an iron table, as illustrated. The builders are the Manville Bros. Co., Waterbury, Conn.



Twenty-eight inch Carriage Turret Lathe, for Valve Work.

TWENTY-EIGHT INCH CARRIAGE TURRET LATHE.

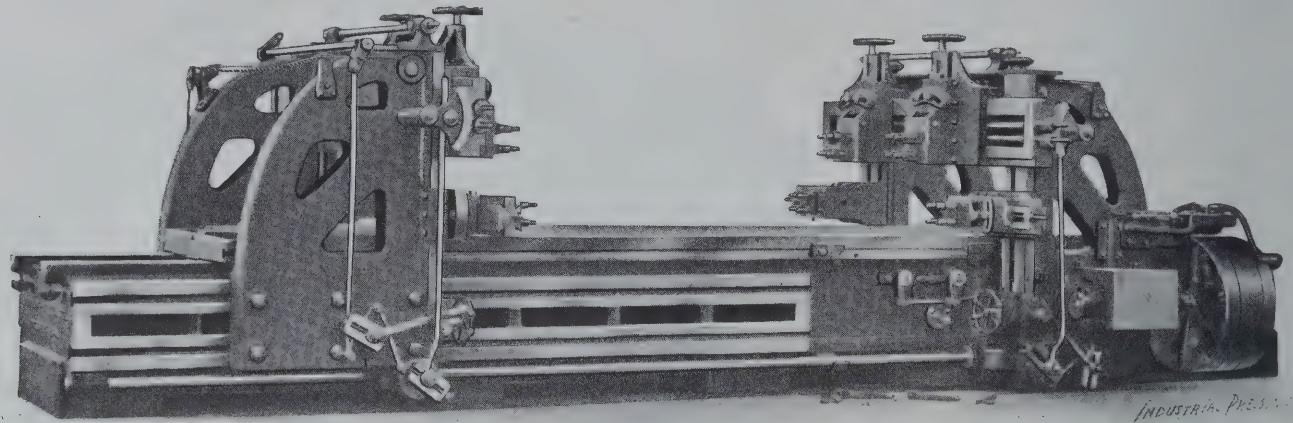
Fay & Scott, Dexter, Me., have lately brought out a 28-inch carriage-turret lathe which is especially fitted for valve work. This is a modification of their regular 28-inch lathe and has double friction back gears and the same style of feed mechanism and lead screw clutches that were described in MACHINERY in March, 1902. In addition to the regular features of the lathe there is mounted on the carriage, in place of the regular tool rest, an octagonal turret having 2½-inch holes, with keyways, for holding boring bars and tools. The faces of the turret are finished and are drilled and tapped, by templet, with a series of holes for fastening special tools or fixtures.

At the top of the turret will be seen the hand lever by which it is operated. A single motion of this lever, forward and back, is sufficient to release the turret, turn the next tool into position and again lock the turret. Being mounted on the carriage, the turret partakes of the regular feeds, both friction and screw-cutting, and may also be used with the cross feed or locked, by dowel pin, so that the holes will come in line with the centers of the lathe. This lathe is mounted on an 8-foot bed with oil pan and pot beneath connected to an oil pump, which is fastened to the back of the lathe and driven from a small pulley on the countershaft. The total weight of the machine is about 8,000 pounds.

LOCOMOTIVE CONNECTING-ROD PLANER.

We illustrate herewith a planer, recently built by the Woodward & Powell Planer Co., Worcester, Mass., that is designed especially to meet the requirements of locomotive builders. The special features of this tool are its simplicity and the adaptability of its design to the special purpose for which it was made. The head housing remains fixed in its position while the rear one can be slid along the bed so that the heads 3½ feet long on connecting rods up to 11 feet in length can be planed with both sets of planer heads in use. The cross rail of each housing carries two heads with an independent power feed for each, and both heads have hand vertical feeds. Four other heads are mounted, one in the face of each housing, making in all eight heads to the machine. These last heads are provided with a vertical power feed and a hand horizontal feed. The belt shifter is a cam device which shifts one belt before the other and is controlled by a hand lever on either side of the bed. There is a device on the rocker for locking the shipper when the belts are on the loose pulleys so that they cannot accidentally work onto the tight pulleys and start the table. Two dogs govern the length of the stroke, and each has a latch which can be raised to allow the table to be run back either way without changing the position of the dogs.

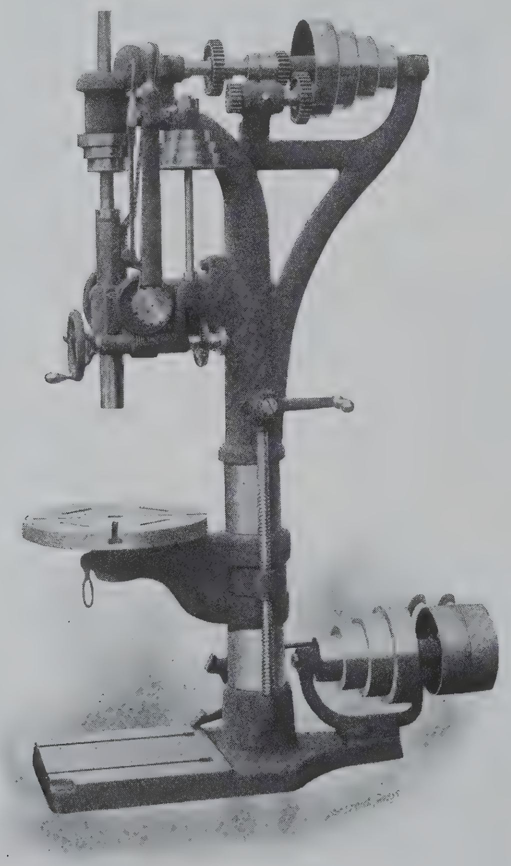
The feed works are very simple, and are designed to give a fine feed or one that is very wide for smoothing cuts. The feed is operated by a positive device, which takes its power from the gearing inside of the bed, so that no load comes upon the shaft except that of moving the heads. The driving gear is such as to give a belt speed of about 90 feet to 1 foot of table movement, the speed being the same forward and back, so that cutting takes place in both directions.



Locomotive Connecting-rod Planer.

TWENTY-INCH UPRIGHT DRILL.

The accompanying illustration shows the latest 20-inch upright drill that has been brought out by the American Tool Works Co., Cincinnati, Ohio. This drill is of new design throughout and has been made heavier and more compact in every way than their former patterns. As shown, it is equipped with wheel, lever and automatic power feeds, back gear and automatic stop. The back gears and automatic feed can be omitted, when desired. The table is raised and lowered by means of a screw and crank. The power feed is engaged or disengaged by a friction which is operated by a conveniently located hand knob. There is an automatic stop to the down feed, which is set by graduations on the spindle and can be readily adjusted. The spindle has a quick return and is counterbalanced.

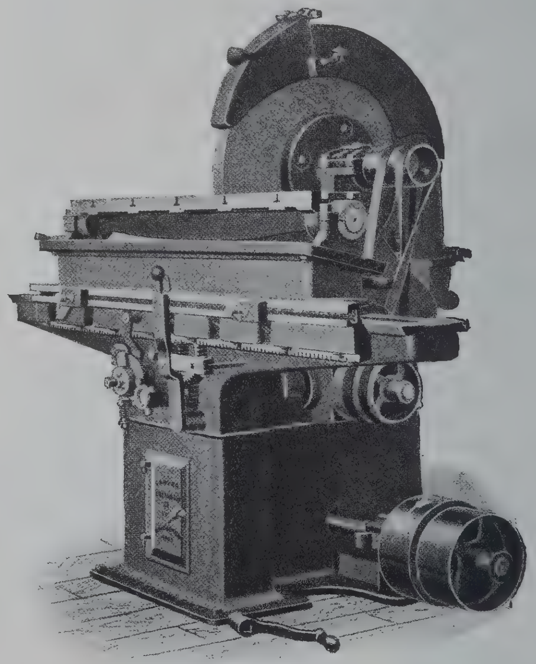


"American" 20-inch Upright Drill.

The back gears, which form a new feature on this size of drill, are engaged very quickly and easily. The belt shifter is so located that the machine can be started and stopped by the foot, leaving the hands free to attend to the work. All levers and handles are placed where they can be easily operated by the workman without changing his position.

THE CARVER KNIFE GRINDER.

The grinder shown in the cut herewith is designed for grinding huller, planer, paper-cutter, or other knives that require a straight and true edge. The knives are fastened to a table which may be set to hold the knife at any angle while the carriage automatically carries it back and forth across the face of the wheel. At the same time the wheel is automatically fed forward onto the knife that is being ground. The pinion that reciprocates the carriage is provided with a clutch which allows either power or hand movements of the carriage and permits the carriage to be stopped at any time without stopping the wheel. The length of the stroke is governed by adjusting stops.



Carver Automatic Knife Grinder.

The feed can be set to grind fast or fine, as may be desired, and when once set for any piece of work, requires no further attention. When ground to the point for which the index is set, the feed ceases to act so that the knife is not unduly wasted by further grinding. The machine can be used either for wet or dry grinding, and when used for wet grinding a constant supply of water is furnished from a tank by means of an automatic pump, located on the back of the machine. The water is fed to the wheel by an adjustable hood which prevents it from being thrown off from the wheel and it then returns to the tank where it is used over and over again by the pump. This grinder is the product of the Carver Cotton Gin Co., East Bridgewater, Mass.

KEMPSMITH UNIVERSAL MILLING MACHINE.

Fig. 1 illustrates an entirely new universal milling machine that has just been brought out by the Kempsmith Mfg. Co., Milwaukee, Wis. This machine has been wholly redesigned with a view to fitting it for the higher speeds and coarser feeds that are possible with the new tool steels. Besides containing the desirable features of their former machines this miller has new features which not only make it more powerful and rigid but also add to its convenience and ease of operation.

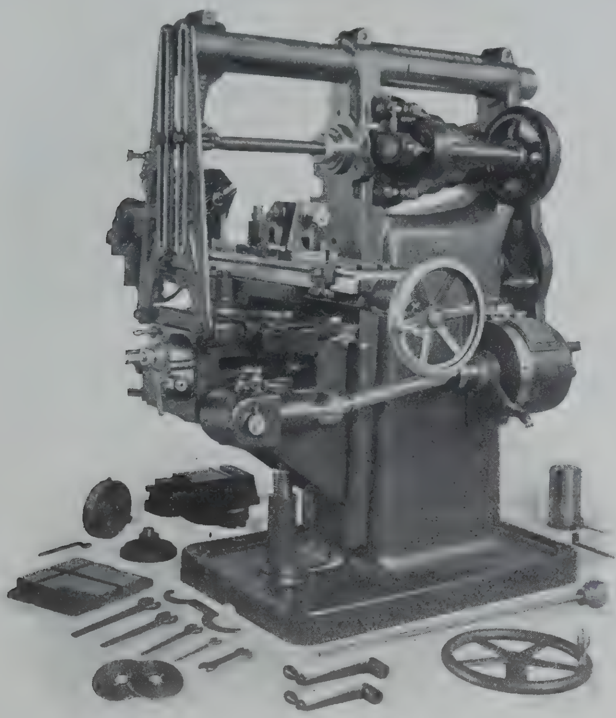


Fig. 1. New Kempsmith Universal Milling Machine.

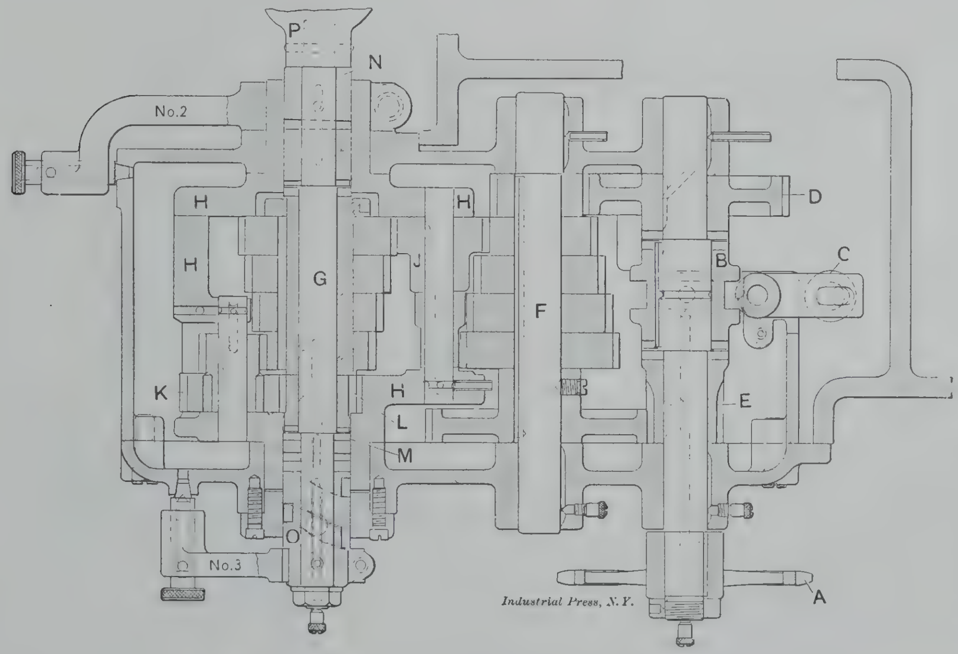


Fig. 2. Diagram of Feed Mechanism of Kempsmith Miller.

The handles for engaging, tripping and reversing all the feeds are at the front of the knee within easy reach of the operator so that he can observe the action on any work in hand and have the movements of the table under absolute control without moving his eyes from the work.

Sixteen spindle speeds are obtained by means of a four-step cone, back gears and double friction countershaft and these, like the table feeds, are arranged in geometrical progression. Fig. 2, which is a view through the center lines of the gear shafts, shows the arrangement of the gearing. Fig. 3 shows that these gear shafts are not in the same plane in the machine but they are so shown in Fig. 2 for the sake of clearness. The feed is direct, driven from the spindle of the machine by means of a chain to sprocket wheel *A* which is keyed to its shaft. *B* is a sliding clutch operated by eccentric shaft *C* and lever No. 1 (Fig. 3) and may be engaged with either *D* or *E*, which in turn will transmit a fast or slow motion to cone gears on shaft *F*. Cone gears corresponding to those on shaft *F* are mounted on shaft *G* in swinging cage *H*. Cage *H* carries four intermediate or idle gears *J* which are made to alternately engage in different pairs of cone gears by means of lever No. 2. Back gear *K* is mounted in cage *H* and drives pinion *L*. *M* and *N* are clutches keyed and pinned to shaft *G*. *O* is a sleeve with a helical groove on shaft *G* operated by lever No. 3 to engage either *M* or *N*. *P* is the universal joint connecting with the feed works in the knee through the telescopic shaft. An index plate showing all the feeds from .004 inch to .150 inch per revolution of spindle is attached to feed gear box and indicates the positions of the levers for the desired feed, as the arrangement of the figures and letters on the index plate is in the same direction as the movements of the levers, the feeds may be read instantly.

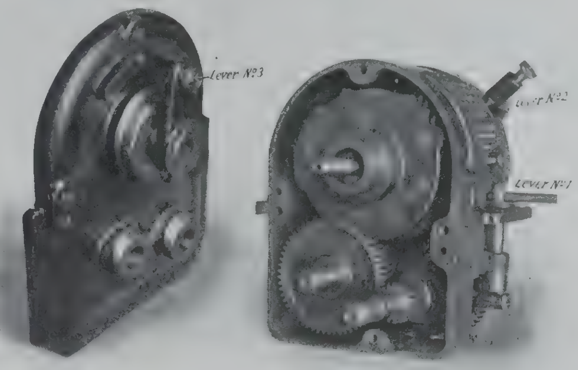


Fig. 3. Feed Box of Kempsmith Miller.

The straight overhanging arm, heretofore used on the plain miller, has been adopted for use on this machine and this may be pushed back flush with the face of the column when it is desired to place high pieces on the table. The vertical screw is now telescopic and permits lowering knee and table the full distance of feed without need of screw hole in floor or foundation.

NEW INDEX HEAD FOR UNIVERSAL MILLING MACHINE.

The illustrations herewith show a new universal indexing and dividing head, for milling machines, that is made, in three sizes, by the Cincinnati Milling Machine Co., Cincinnati, Ohio. The method of indexing by means of index pointer, plates and connecting gearing is the same as that in general use in mechanisms of this kind. It will make all divisions up to and including 360 and a great many beyond this number. Some of the details are entirely new, particularly the method of taking up the wear between worm and worm wheel and the arrangement for clamping the swivel block at an angle. Angular settings of the work spindle can be made from 5 degrees below the horizontal to 50 degrees beyond the perpendicular when geared to universal machines. When fitted to plain machines, it may be swiveled through a complete circle if the front index plate is removed.

The worm and worm wheel may be thrown out of mesh for any position of the work spindle by turning the T-bolt, Fig. 2, through half a turn, and this is accomplished without removing any parts, slacking up any lock nuts, or disturbing any adjustments whatever. The end of this T-bolt is made eccentric and engages a slide attached to the worm casing, which slide is free to move endwise, and the worm casing itself being confined between the walls of the swivel block, as shown in Fig. 3, can only move in a vertical direction. The slide takes the horizontal motion of the eccentric end of the T-bolt. From this it will be seen that the worm moves away from, or toward the worm wheel in a plane, perpendicular to the axis of the worm wheel, that is, a plane through the line *XX*, Fig. 3. Compensation for wear between these two members is obtained by adjusting the screws which attach the slide holder to the worm casing, all of which is evident from Fig. 2. It will be noticed that this compensation for wear is made along the same straight line *XX*, Fig. 3, so that these parts may be adjusted repeatedly without danger of disturbing their alignment.

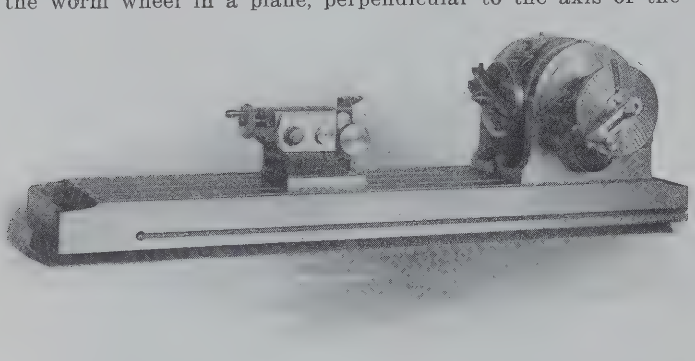


Fig. 1. Index Head of Cincinnati Milling Machine.

The swivel block has large trunnions of diameter *A*, Fig. 2, and it is firmly secured in any position by means of the clamping straps shown, which are made to grip the trunnions by tightening two cap screws, one of which is shown in Fig. 3. These trunnion bearings have an arc of contact of 360 degrees; are always fully protected, no part of them being exposed at any time, no matter at what angle the spindle is set. Instead of the usual single notch on the index plate for locking, there is a series of small notches milled on its edge, which permit of moving it a very small amount. This is very often convenient when adjusting work to the cutter. The tailstock has the usual elevating center. It may be set at any angle up to 10 degrees above or below horizontal to bring the centers in line with the center of the work when milling taper reamers or similar work.

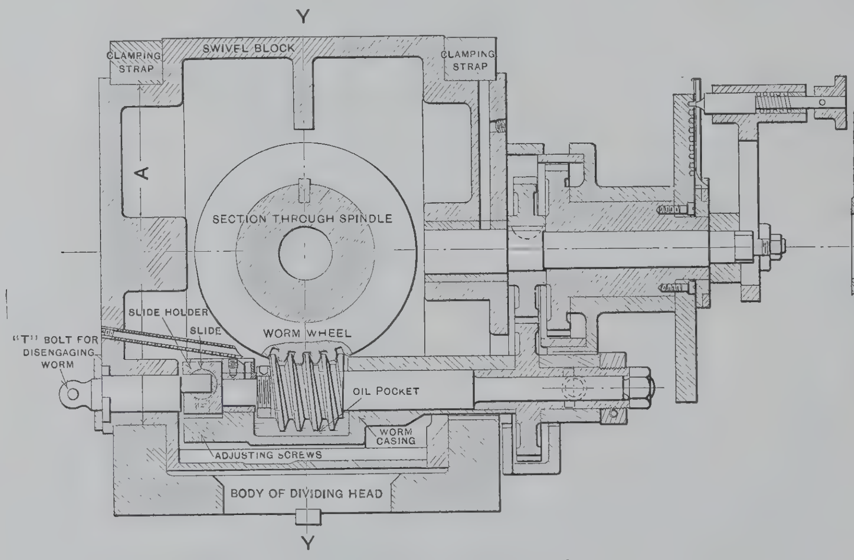
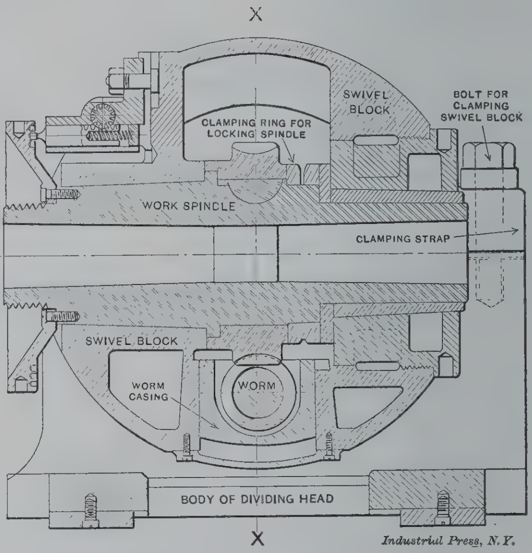


Fig. 2. Cross Section through Index Head.



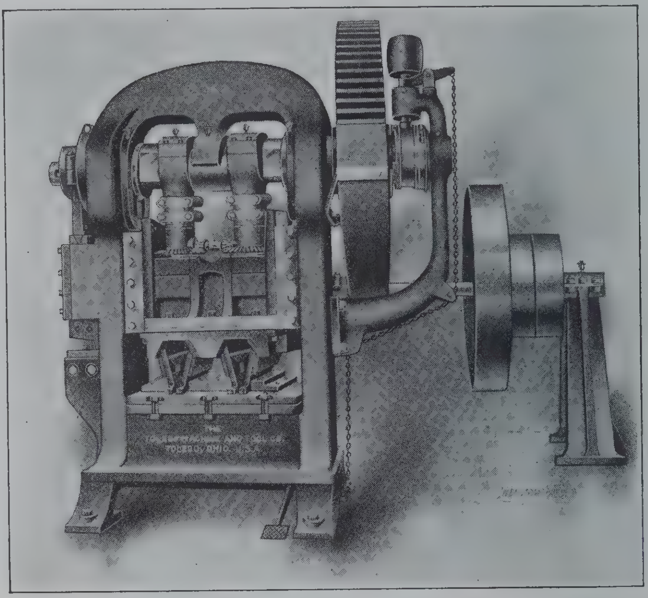
Industrial Press, N.Y.

Fig. 3. Longitudinal Section through Index Head.

A NEW FORGING PRESS.

A new type of forging press, that is adapted for general tool forging, is shown in the photograph herewith. As shown, the press is equipped with a special fixture for forging pick-eyes, but this is a separate fixture and may be replaced by one for any other purpose desired, the distance from the bed to the slide being sufficient to accommodate special tools or fixtures for a large variety of forgings.

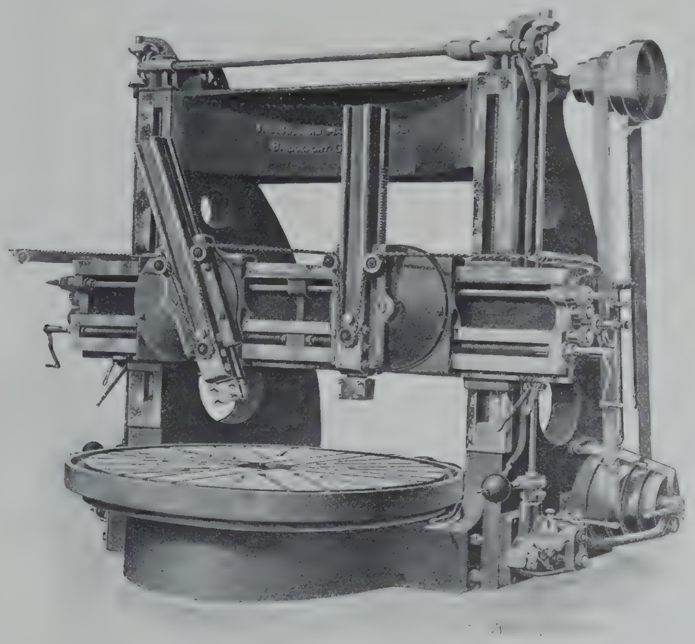
The press is equipped with outside cut-off which has power for shearing or cutting off bars of considerable size either hot or cold. It has an improved gravity releasing device in which the releasing of the clutch does not depend in any way upon springs. By means of this clutch the machine is under control of the operator at all times. The outside trimming attachment may be provided or not, as desired. The press illustrated is provided with adjustable pitmans, but solid ones can be used when they are preferred. The frame is in one piece, thus giving great rigidity. The press is built in three sizes by the Toledo Machine & Tool Co., Toledo, Ohio.


New Tool Forging Press.

A NEW TEN-FOOT BORING AND TURNING MILL.

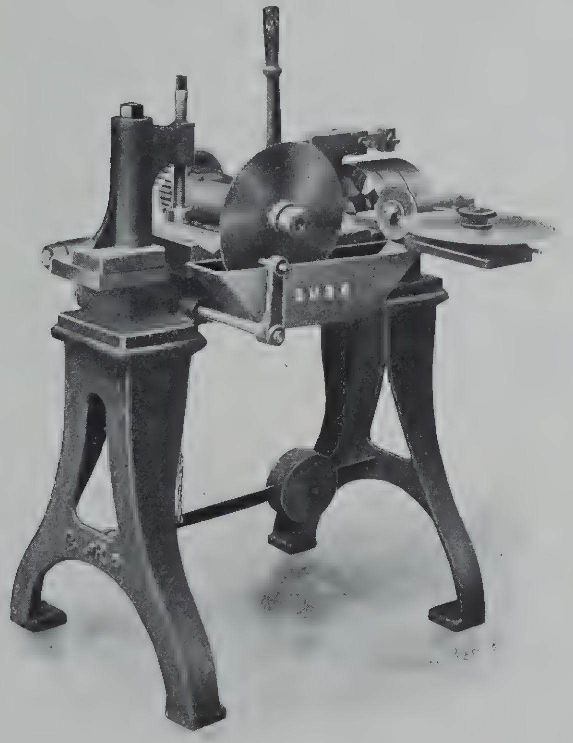
The Bullard Machine Tool Co., Bridgeport, Conn., have just placed on the market the new boring and turning mill, of unusually large proportions, that is illustrated herewith. Although rated as a 10-foot mill it has an actual maximum swing of 123 inches, and a maximum height under the cross rail of 84 inches. The machine is driven from a five-step cone by means of a 4-inch belt. The table is turned by a spur pinion running in an internal spur gear, and the intermediate gearing between this pinion and the driving shaft may be manipulated so as to give three different ratios of the driving gear. This, together with the five belt speeds, gives a total of 15 table speeds. The total ratio of the gearing between the driving shaft and table is 252 to 1, so that high belt speeds are employed. To enable the machinist to shift the belt, running at this high speed, swinging guides are placed around each side of the belt so that it may be shifted from one step to another by a simple movement of levers. All of the driving gears are completely covered with iron casings and are run in a bath of oil. The shifting of the driving gears is all accomplished by levers operated from the side of the machine.

The spindle is 20 inches in diameter by 60 inches long and the lower end runs in an adjustable quartered box so that any possible chatter or shake may be prevented. The spindle support, which is 50 inches in diameter, is accurately fitted and runs in a bath of oil, the height of which is maintained by means of an indicator placed in a conspicuous position.



Ten-foot Boring and Turning Mill.

Two heads are mounted upon the crossrail and each is driven from an entirely independent mechanism operated from its respective side of the machine. Each head has horizontal feed of 1-32 inch to 1 inch and vertical feed of 3-128 inch to ¾ inch, both of which are positive. In addition to this the head on the right-hand side of the machine has a thread-cutting device which cuts threads from 1 to 12 per inch, including the 11½. Each head has a quick traverse, in either direction, driven by friction gearing, which is thrown into operation by the hand lever that may be seen at the side of the machine, fitted with a counterweight for keeping it normally out of action.

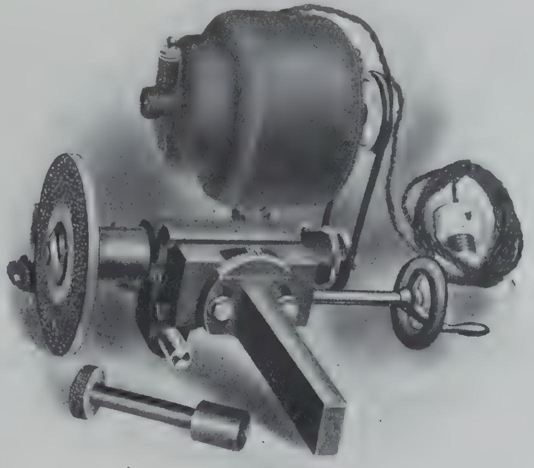


"Burr" Cold Saw with Grinding Attachment.

The screw-cutting, power and quick feeds are so arranged that putting any one of them in operation places the others out of action so that any accident from interference is impossible. The tool bar has a vertical movement of 48 inches. The crossrail is raised and lowered by power and all of the flat bearings are provided with tapered gibs. The mill, as shown, is belt driven, but when desired it may be operated by a 20 horse power electric motor. The total weight of this machine is somewhat over 90,000 pounds.

ELECTRICALLY-DRIVEN TOOL POST GRINDER.

L. S. Heald & Son, Barre, Mass., have just placed on the market the electrically-operated toolpost grinder shown in the accompanying half-tone. It is adapted for use in the toolpost of either lathe, planer, shaper or milling machine. The motor is mounted just above the spindle and drives it by a round belt running over grooved pulleys. As these pulleys may be changed for others of different diameters any speed of the spindle may be attained, thus fitting the machine for carrying large or small grinding wheels. The tool is provided with a universally adjustable gage, or rest, for the work and also with an extension spindle for internal grinding. It has an independent feed of three inches by means of a worm and hand wheel. The base, where the grinder is bolted to the holder, is graduated so that the spindle may be set at an angle for grinding tapers. The motor may be wound for alternating, as well as direct current, of any voltage, and the power is supplied by connecting to any convenient incandescent lamp socket.



Electrically-driven Tool Post Grinder.

NEW "BURR" COLD SAW.

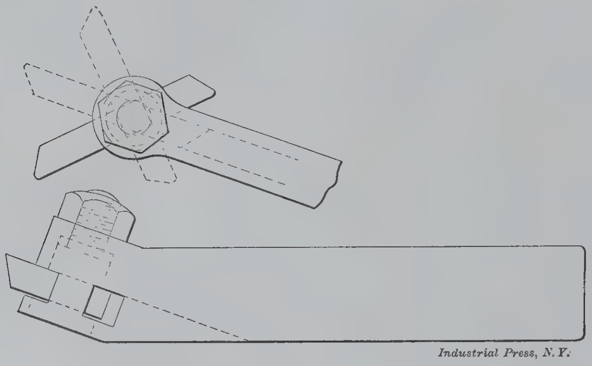
The photograph herewith shows a new cold saw that has just been placed on the market by John T. Burr & Son, Brooklyn, N. Y. This machine uses a 10-inch circular milling saw 1-16 inch thick, and has a capacity for cutting off stock up to 3½ inches, round or square. It is operated by means of a pair of cut pinions, worm wheel and worm. The saw carriage or slide is fed by gravity, the weight being adjustable on the lever and the movement being transmitted to the carriage by a chain running over a grooved sleeve. The vise and vise arch may both be removed from the frame and fixtures for cutting special work substituted.

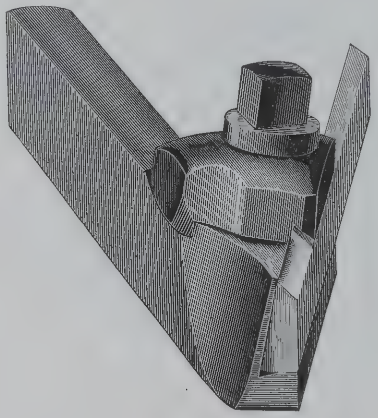
The saw runs in a bath of oil and a stock stop provides for cutting any number of pieces to the same length. The machine is especially adapted to cutting up disks, gears, collars, etc., and for any work where it is desired to have the ends parallel. It is claimed that it will cut off to within .005 inch of parallel. The machine is furnished with a saw grinding attachment which is operated by a pulley on the driving shaft. For the purpose of illustration a saw is shown both on the saw arbor and also in position to be ground.

FOUR NEW LATHE TOOLS.

COMBINATION STRAIGHT AND SIDE TOOL HOLDER.

The tool holder illustrated herewith is manufactured by Carr Bros., Syracuse, N. Y. It is, in a way, a combination of three tools, taking the place of a right-hand, left-hand and straight holder. The cut shows the blade in one of the side positions while the dotted lines show how it can be turned to the other hand or straight. The blade is locked in its position by the nut on the top and the angle of the clamp is such as to give the proper rake without top grinding. When in the off-set position it has an additional rake, as this position raises the cutting edge.


Industrial Press, N. Y.

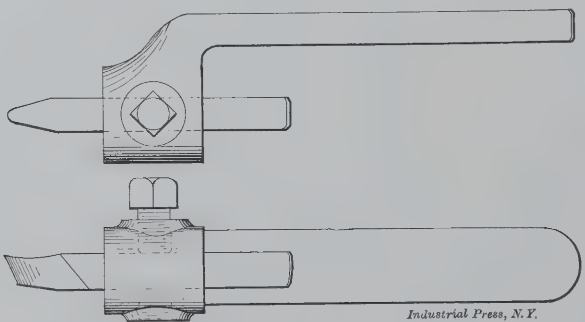

"Champion" Right-hand Side Tool Holder.

"CHAMPION" SIDE TOOL HOLDER.

This tool holder is designed for facing work and also forms a convenient tool for turning or reducing stock. The cutter is supported both on the side and bottom and is held by a wedge shaped cap that clamps it firmly in place. This holder is made both right and left hand, the one shown in the cut being the right hand tool. It is made in three sizes and is the product of the Western Manufacturing Co., Springfield, O.

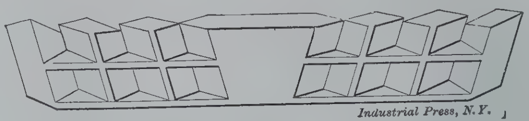
RIGHT AND LEFT HAND OFF-SET TOOL.

This tool is designed for using extra large cutters made of self-hardening tool steel and is made very rigid to stand the excessive strains which are encountered in heavy work. It is fitted for use on lathe, planer or shaper and may be used either as a right or left-hand tool, as desired, by simply changing the set-screw from one side to the other. As will be seen from the cut, the offset of the holder permits the cutter to be removed for grinding without taking the holder from the tool post. This tool is made by E. A. Warburton, and is for sale in ten sizes by N. S. Ashworth & Co., Amber and Adams Streets, Philadelphia, Pa.


Industrial Press, N. Y.

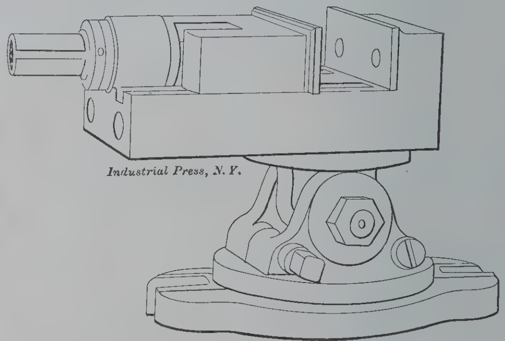
MULTIPLE DIAMOND-POINT TOOL.

A novelty in the way of a diamond-point tool is shown in the sketch herewith. The tool is drop-forged and has three points at each end connected by webs, and as each point becomes ground away so that it is no longer useful, it is broken off and the next point is smoothed up on the grinder and is then ready for business. In this way practically the whole of the steel comprising the tool is available for use. The tool is made by the Jaques-Bush Mfg. Co., Providence, R. I.


Industrial Press, N. Y.

TWO TOOLMAKERS' VISES.

The Atlas Machine Co., Providence, R. I., have just placed on the market two new vises designed especially for holding work at angles in the planer or milling machine and for such similar purposes as occur in general toolmaking work. The body of the vise shown in the cut may be tipped and clamped at any angle up to 55 degrees and may also be swung around the base in a complete circle. A series of graduations on the base, in connection with a pointer, indicate the angle at which the vise is set, while a clamping bolt retains it firmly in position. Both jaws have hardened steel plates which are held in place by screws so that removal and change from the rough to smooth jaws is the work of but a few minutes. The other vise is similar in construction, but is provided with the rotary movement only, the jaws remaining fixed in a horizontal plane. In this vise a screw is provided for locking the table in any desired position.


Industrial Press, N. Y.

"Atlas" Toolmakers' Vise.

A New Corundum Wheel.

A NEW CORUNDUM WHEEL.

The Vitrified Wheel Co., Westfield, Mass., have for some time been turning their attention to the corundum that has been found in large quantities in Canada, and their investigations and experiments have developed the fact that this corundum is unusually pure and efficient and that its cutting and lasting qualities are quite remarkable. An analysis of this abrasive shows that it contains 95 per cent. of pure corundum. The company is now placing on the market wheels made from this Canadian corundum obtained from the "Craig" mine, which are claimed to be very rapid cutting wheels. Owing to the absence of non-cutting properties these wheels will not glaze. Experiments in grinding tough and hard steel have shown that there is an almost entire absence of heat generated either in the wheel or in the material being ground. This shows that instead of having to crowd the work against the wheel until it reaches an extreme heat, the wheels cut so rapidly that the work is completed without creating enough friction to cause heating.

* * *

NEW TRADE LITERATURE.

The Emerson Electric Mfg. Co., St. Louis, Mo. Advertising card calling attention to the "Emerson" fan motors, and especially to desk fans for office use.

The W. C. Young Mfg. Co., Worcester, Mass. Catalogue of lathes, punches and shears. The 9, 10, 12, 13 and 14-inch engine lathes are shown, and also a set of lathe tools.

The Challenge Machine Co., 3223 Turner St., Philadelphia, Pa. Booklet calling attention to the "Challenge" emery grinders and illus-

MACHINERY.

July, 1903.

THE NEW FOUNDRY OF THE BROWN & SHARPE MFG. CO.—1.

The original building of the Brown & Sharpe Mfg. Co.'s plant at Providence, R. I., was erected in 1872 and was that part of the present main building where the office is now located. Eight years later, in 1880, a foundry was built directly west of the main building, which has since supplied castings for the works. This is a one-story structure, 266 feet long, with large window area and monitor roof and although 20 years old is much more modern in appearance than many buildings erected at the present time. Since this foundry building was completed the floor area of the machine shops has been increased several times by extensions to the main building and the addition of other buildings. These have increased the demand for castings to such an extent that it was impossible for the foundry to supply these demands and it became imperative that another foundry should be erected. This has recently been done, and the new foundry is now completed, or nearly so, and in running order.

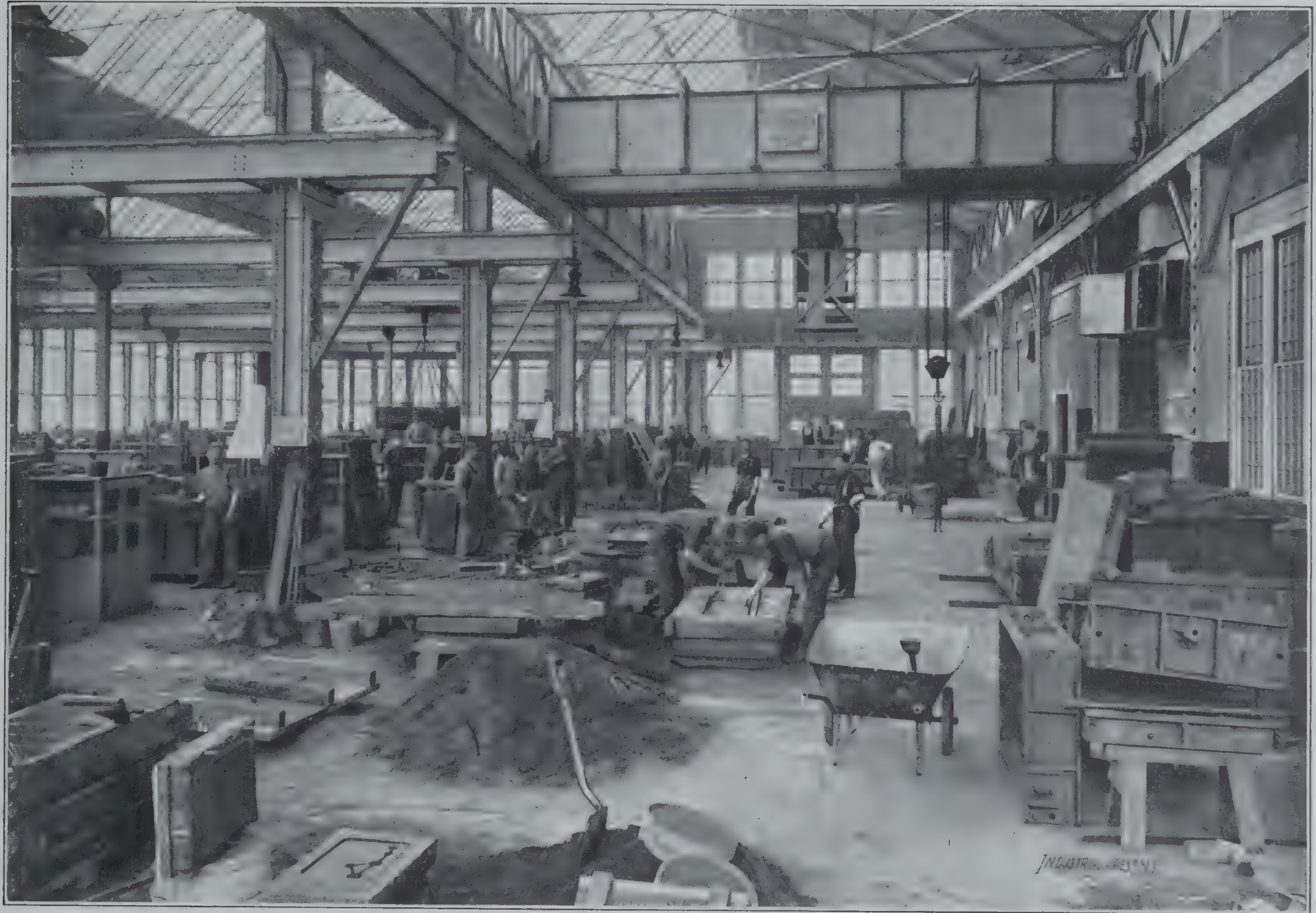


Fig. 1. Molding Floor of Heavy Foundry—This Foundry is thoroughly Lighted, Heated and Ventilated and the entire Floor Area is served by Traveling Cranes.

In planning the new building, provision for future growth was made and it is intended eventually to have all the castings made in the new foundry. The set of buildings comprising the foundry are located on a plot of land on the northwest corner of the Brown & Sharpe Mfg. Co.'s ground, where there is ample room for future extension of the buildings. The plot is on the base of a hill or bluff sloping abruptly to the north and east, which necessitated considerable excavating. It is really a case of a foundry "under a hill," but instead of being a disadvantage, this conformation of the land has proven decidedly advantageous, since it has made possible the construction of storage bins for the foundry sand on a level with the foundry floor and on top of these a pig iron area with coke pockets on a level with the cupola charging floor.

In Fig. 6 of the group of views is shown the lower row of sand bins with the driveway and storage room on top. At the left is seen one end of a bridge leading to the charging floor. The upper building is for coke. Inasmuch as both structures are built against the side of the hill it was possible to arrange driveways leading on to the top of the sand bins and also on top of the coke pockets, so that both can be filled through manholes located in the roofs of the structures.

In Fig. 4 is a general plan of the foundry and in Fig. 2 an outline drawing representing the building as seen from the east, or from the top of the page containing the plan view. In the arrangement, taken as a whole, the feature to first attract attention is the division of the foundry proper in two parts for the light and heavy work, with the cupolas and charging floor between. In Fig. 4 the heavy foundry is located at the top of the drawing; next comes the cupola building containing, in addition to the cupola, the iron flask shop at the right and the core ovens and core room at the left. Next is the light foundry and finally the pickle beds and casting cleaning room, and the storage room. Above the storage room are lavatories and pattern storage rooms, while in the cupola building the wood flask shop is located, over the core room. All the other buildings are of one story only. In Fig. 3 as much of the plan as is drawn with solid lines has already been completed; but sufficient land is owned to enable

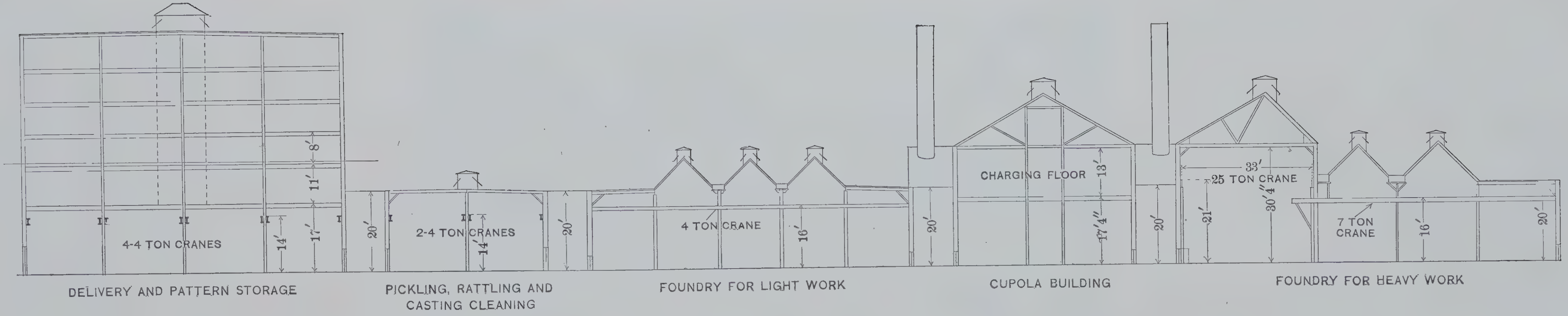


Fig. 2. Outline Sketch Showing Sectional End Elevation of Foundry Building.

the company to extend the various departments in a westerly direction, as indicated by the dotted lines, and foundations for the extensions are already in. It is expected eventually to erect a power building, as indicated, as a central power plant for the heating, lighting and power complete, for the whole foundry. At present boilers for heating are located in the delivery room.

From the general plan it will be seen that the different buildings are separated by light and air spaces about 10 feet wide, in the walls of which are side windows like the windows in the outside walls, thus making the central parts of the buildings much lighter than they would otherwise be.

The various departments are connected by a gangway extending from the storage building to the heavy foundry. Underneath the floor is a trench containing the piping for the water and steam distribution, etc., which is covered with iron plates that serve as a trackway for transferring castings, patterns and supplies on trucks with flat-tread wheels. The convenience of having the cupolas, flask shops and the core room so centrally located between the heavy and light foundry will be obvious. It will also be noticed that the cupola room is very centrally located with respect to the cast-iron area and coke bins. The core ovens are so designed that the heavier cores, which are used in the heavy foundry, may be withdrawn from the ovens on the foundry side after having been made in the core room and baked in the ovens, which avoids any additional handling.

In the construction of the buildings steel and glass have been used to as great an extent as possible. The walls are almost entirely of glass, and most of the windows have no brickwork between them. The sides of the window frames incase steel I-beams supporting the roof, or the floors above, as the case may be. In the buildings having floors above the first floor cinder concrete is used for the floors. The distance between the floor beams is 10 feet in the storage building and 5 feet in the cupola building, and the concrete is 5 inches thick, reinforced by twisted rods placed 1½ inches from the lower side—the construction being what is known as the "Ransome" system of fireproof floor construction. The floor beams are standard I-beams, sufficiently heavy to carry the floor loads and incased in two inches of the concrete for fireproofing. The concrete is overlaid with spruce flooring 2 inches thick, nailed directly to the concrete and covered with a wearing surface of ⅞-inch maple.

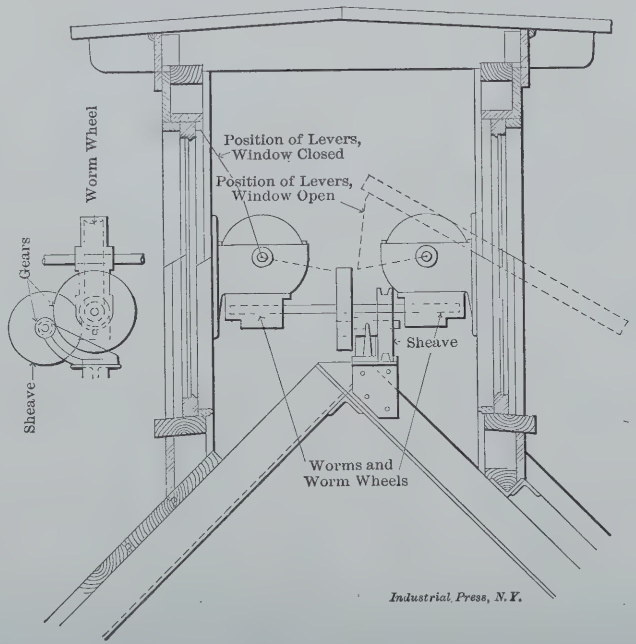
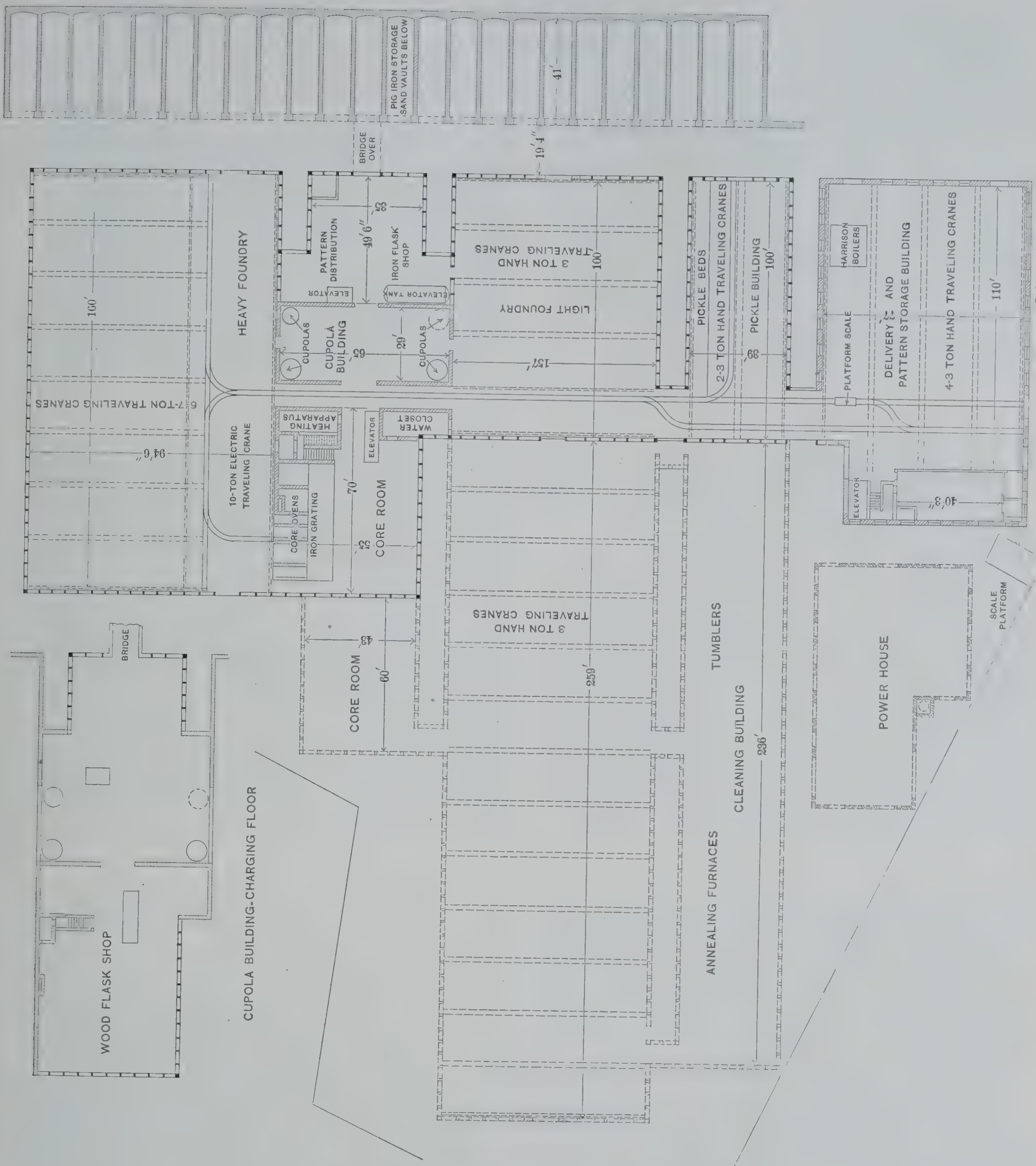


Fig. 3. Ventilation Arrangement of Monitor Roof.

In the two foundry rooms lighting is effected by the large windows in the walls and by windows in a modified form of saw-tooth roof, as shown in Fig. 2. Starting at the right in Fig. 2, it will be seen that the heavy foundry consists of two sections; one considerably higher than the other, which is served by a traveling crane, and the lower section, which is served by several hand cranes on tracks at right angles to the tracks for the main crane, the object of which is to make it possible to deliver ladles of iron from the cupola to the hand cranes as well as to handle castings, flasks, etc.

The roof of the high section resembles the regular saw-tooth roof, with one slope longer than the other and windows in the short slope facing the north. In saw-tooth roofs, however, the windows are usually at an angle of about 70 degrees with the horizontal, so as to exclude the direct rays of the sun when this luminary is high in the heavens in the summer time. In this roof the window slope makes an angle of 45 degrees, giving, of course, a much larger projected light area on the floor below, while provision is made for excluding the light up to the 70-degree angle by placing a monitor roof at the apex of the main roof, and extending its whole length. The monitor is high enough to practically shut out all direct rays from the floor and at the same time the benefit is gained of the superior lighting secured with the 45-degree roof.

The roofs covering the low section of the heavy foundry and also the light foundry are on the same plan as the roof over the high section of the heavy foundry; but in these cases each slope of the different roof sections is at an angle of 45 degrees, which gives a narrower span between the columns.



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The south slopes of the roofs are covered with copper and the valleys with asphalt. The pitch of the roofs and width and slope of the valleys are sufficient to insure rapid disposition of the snow and water in the winter time—a feature generally lacking with the ordinary saw-tooth type of roof.

The monitors have windows for ventilation at the sides, and a section of one of them is shown in Fig. 3, in which is outlined the mechanism for opening and closing the windows. This is done from the floor by a chain passing over a sprocket wheel which is geared to a shaft carrying a worm at each end meshing with wormwheels on shafts running lengthwise of the roof. Levers at intervals on this shaft connect with the windows. This insures complete ventilation, so much to be desired in a foundry, whether in the winter or summer. The sash on the south side of the monitor are covered with galvanized iron to keep out the direct rays of the sun.

The efficiency of the lighting arrangements is manifest in Fig. 1, which is a view in the heavy foundry. This shows the building to be literally a glass house with a north light coming through the roof, and side light through the walls. Unlike most foundries this one has a cement concrete floor, adding to its cleanliness. A pit at the further end is used for molding the heaviest castings. This view also shows the crane arrangement, a Sellers electric crane being used for the high section and hand cranes with electric hoists for the low section. The foundry is equipped with stands containing shelves and lockers, one of which is seen at the left, for the reception of the molders' tools.

In the light foundry and other sections of the plant substantially the same crane arrangement is used as in the low section of the heavy foundry, viz., hand traveling cranes with electric hoists. By supplying each bay with one crane of this

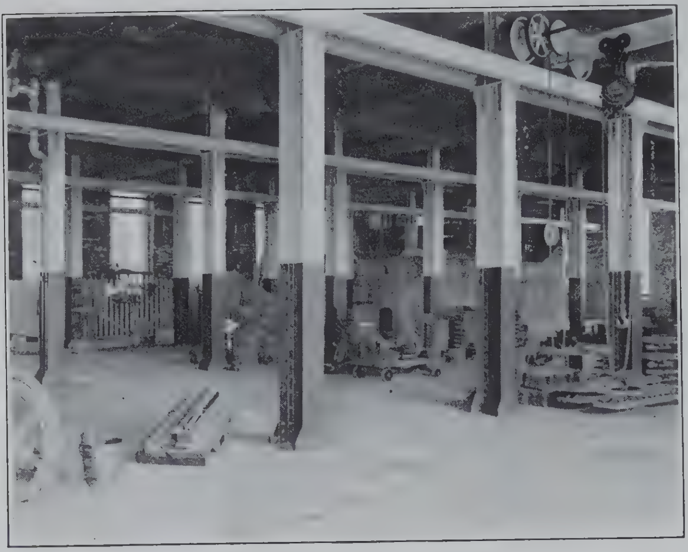


Fig. 5. Delivery Room.

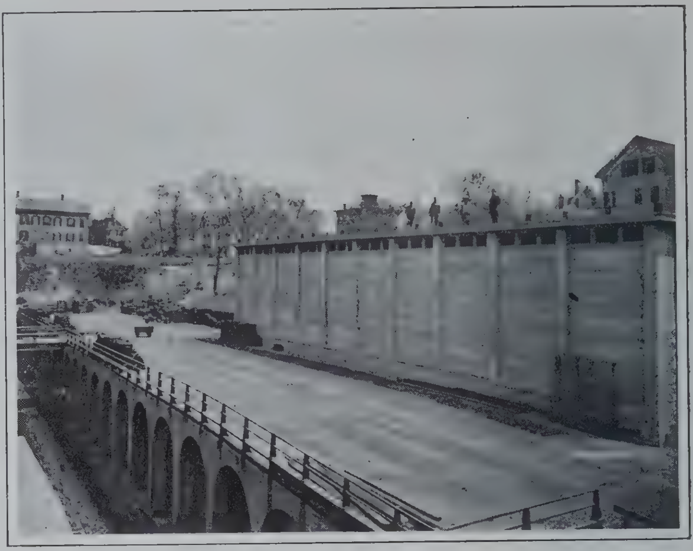


Fig. 6. Pig-iron Area with Sand Vaults below and Coke Pockets above.

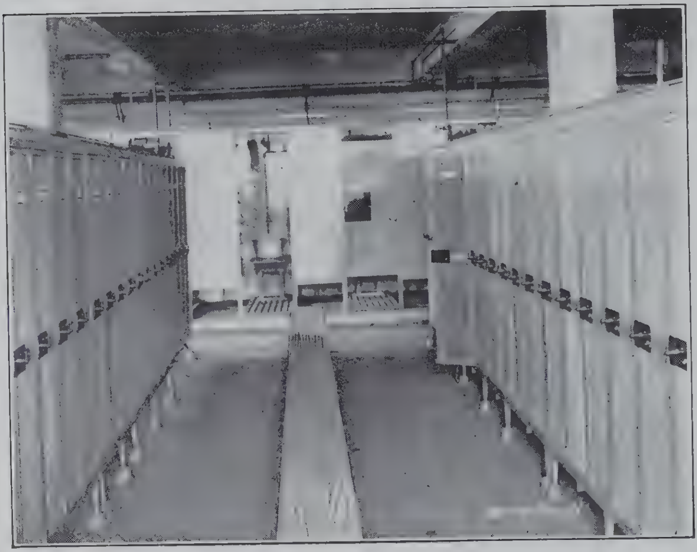


Fig. 7. View in Wash Room showing Lockers and Bath Rooms in rear.

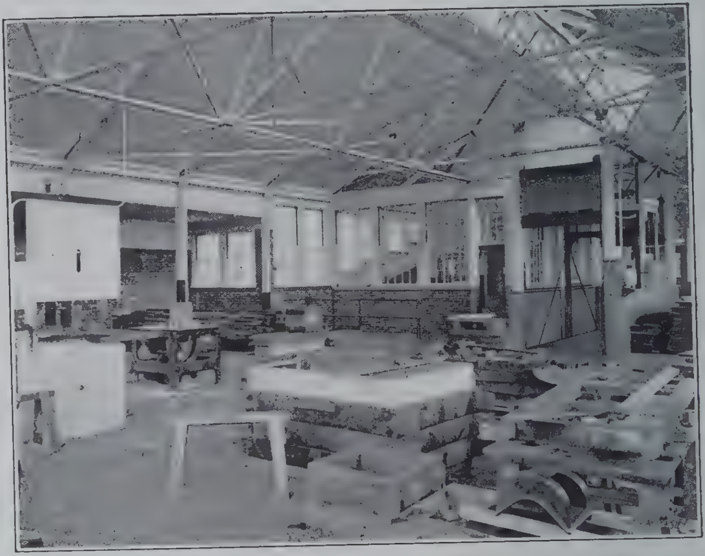


Fig. 8. Interior of Flask Shop showing Motor-driven Machines and large Elevator.

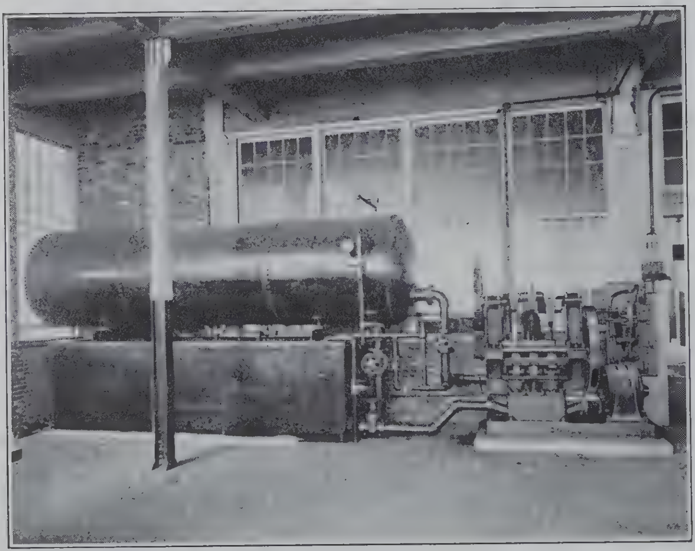


Fig. 9. Ten-H P. Induction Motor Geared to Triplex Pump, with Pressure Delivery Tanks for Operating Large Plunger Elevator.

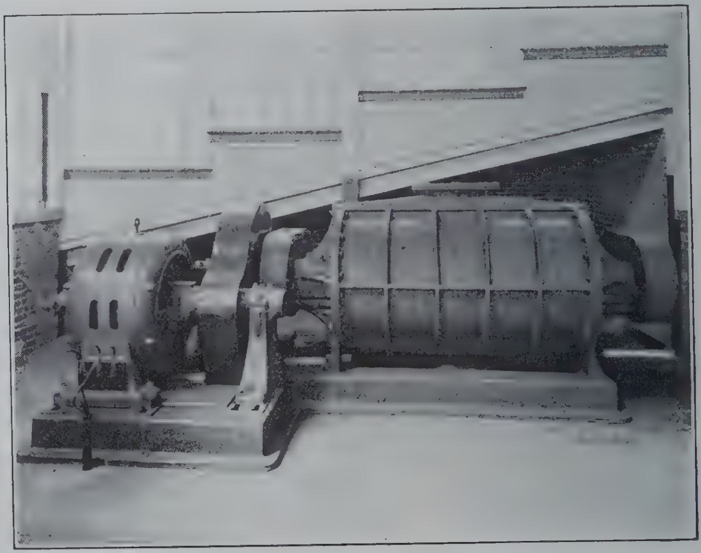


Fig. 10. Thirty-H. P. Induction Motor, Geared to No. 6 Roots Blower for Cupola Blast.

description work can be handled very efficiently without delays incident to waiting for a crane or helpers, and at the same time the whole floor area is served efficiently.

The hot blast system of heating is used, as far as practicable, and direct radiation for such rooms as cannot be reached by the indirect system. The conspicuous thing about the heating system is the absence of the usual sheet metal pipes leading to all parts of the works. For the heavy foundry the coils and fans are located in the cupola building and the hot air is discharged into the foundry through a single duct entering at one side, having five openings arranged in a semicircle so as to point to the different sections of the room, and diffuse the air through the room without creating drafts. For the light foundry, pickle room and office there is a second heating plant located so as to easily deliver air through the ducts leading to the different departments.

Cement concrete is used throughout for the arches of the sand vaults and the walls of the coke bin, the concrete being mixed in proportion of 1 of cement, 3 of sand and 6 of broken stone. It is necessary to have the roofs of these two structures strong enough to sustain heavy loads, to withstand the wear of trucking and at the same time to be waterproof. The roof of the coke pocket is supported by I-beams and consists of 2¾-inch plank on furrings. Over these are three or four courses of felting paper, laid in roofing pitch and covered finally with chestnut planks spaced ¼ inch apart and the joint poured with pitch. The arches of the sand vaults are covered on top with wooden paving blocks. The iron fence built around the edge of the pig-iron area, on top of the sand vaults, is one of the numerous features about this foundry plant worthy of mention. The fence posts are of cast-iron and what corresponds to the lower rail of the fence is of heavy channel iron placed in a horizontal position and calculated to resist the attacks of unruly truck wheels. The upper rails of the fence are of wrought iron pipe. The electrical equipment of the buildings is complete and somewhat unusual for a foundry. The cranes are equipped with Westinghouse 500-volt direct-current series motors. For woodworking machines in the carpenter shop, the rattlers and the cupola blower, the General Electric Co.'s three-phase induction motors with 220-volt alternating current are used. These motors start easily under load. Their armatures are provided with a short circuit switch placed in such a position that at starting all the resistance is included in the armature circuit. As the motor increases in speed the resistance may be gradually cut out by the movement of a handle at the end of the armature shaft. By this arrangement a large starting effort is obtained and with this equipment the alternating current appears to give entire satisfaction.

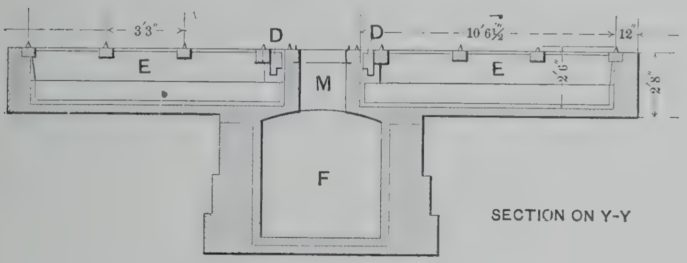


Fig. 12. Section through Pickle Bed.

In Fig. 10 is shown a Roots blower which supplies the blast for the single cupola that is at present erected—one of the Colleau pattern, made by Byram & Co., Detroit, Mich. This blower operates at 140 revolutions per minute and is geared directly to a 30 horse power induction motor. In order to secure quiet running outboard bearings were provided, both for the motor and the blower shafts. This gives a rigid support for the high-speed gearing and secondly, insures quiet running, with little liability to shut-downs.

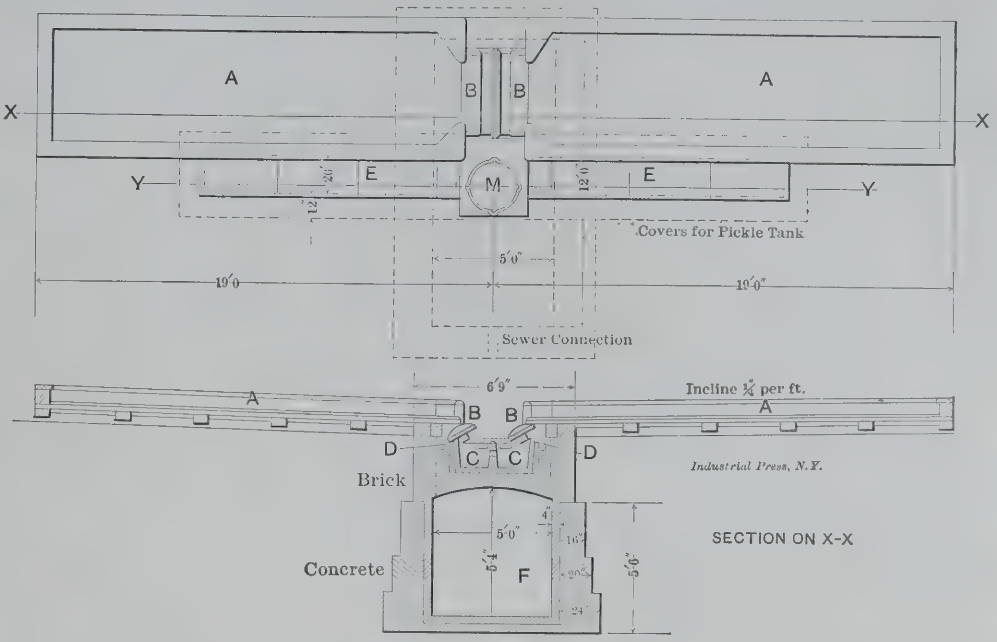


Fig. 11. Plan and Section of Pickle Bed.

A hydraulic elevator runs from the basement to the carpenter shop and the electrical equipment, pumps, tank, etc., for its operation are shown in Fig. 9. The elevator is made long enough to take boards of usual lengths in a horizontal position, instead of having to stand them on end. It is shown at the right in Fig. 8. The elevator pumping plant has a triplex Goulds pump, driven by a 10 horse power induction motor, which is started and stopped automatically on the variation of the tank pressure by means of a Mason regulator operating an oil switch of General Electric design. The upper or cylindrical tank, Fig. 9, is the pressure tank communicating with the elevator cylinder, and the lower or rectangular tank is for the discharge from the elevator cylinder and from which water is pumped to the pressure tank. The operation of the whole apparatus is entirely automatic, maintaining a constant pressure in the tank.

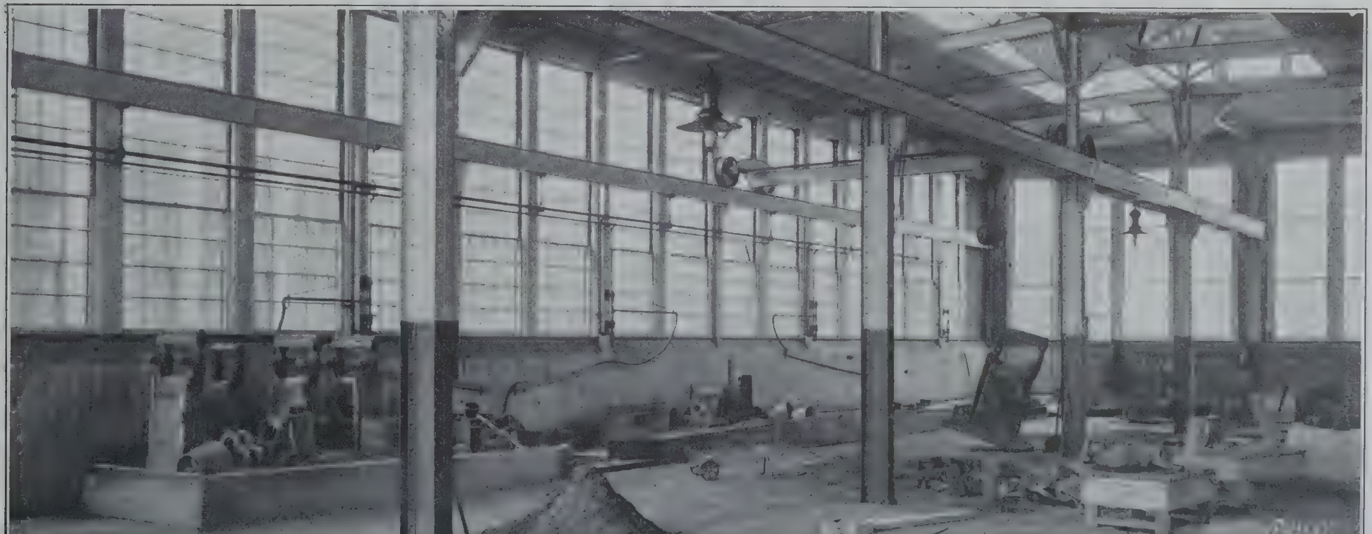


Fig. 13. Casting-cleaning and Pickle Room, showing Pickle Beds.

The pickle beds located in the pickling and casting cleaning building are of substantially the same design used by the Brown & Sharpe Mfg. Co. in their former foundry and are shown in detail in the illustrations, Figs. 11 and 13. Each bed is made in two sections, sloping toward the center, and is arranged to drain either into the acid tank or into the sewer, as desired. In Fig. 11, *AA* are two sections of the bed. The lower part of Fig. 11 is a sectional view taken on the line *X X*. *B B* are two tilting troughs that, when tipped one way, allow the liquid that has been poured over the castings to drain into the channels *D D* and, when tipped the other way, to drain into the channels *C C*. These latter channels drain into the settling chamber *F*, which is connected with the sewer. When the castings are washed off with a hose the water is allowed to drain into the chamber *F*, which allows the sand to settle and prevents it from going into the sewer. When using the acid, it drains into the channels *D D* and thence into the acid tanks *E E* shown in Fig. 12, which is a sectional view taken on the line *Y Y*, Fig. 11. The acid tanks are covered with wooden covers and by removing one of these the acid can easily be dipped up and poured over the castings. The manhole *M* gives access to the settling chamber, for cleaning. In Fig. 13 the swinging brackets by which the hose connection is had with the water pipe above the pickling beds, are clearly shown. Attention should also be called again to the excellent light, the walls of this room being almost entirely of glass.

The delivery and storage building, indicated in the diagram, Fig. 2, is at present only two stories high, but plans have been made for four additional stories to be erected later. Part of the second floor is used for lockers, wash rooms and bath rooms for the employees. The lockers are of expanded metal and steam pipes pass underneath the lockers not only to warm the room but to dry damp clothing in rainy weather. The work of the foundryman is so dirty that facilities for changing clothes and for bathing should be adjuncts of a modern plant, and these points have been carefully studied in this instance. In Fig. 7 is a view of the lockers, with two of the bath rooms shown in the background. It will be noticed that there is a bench between the two rows of lockers—a very simple affair but a great convenience to the employees when changing their clothing. The walls of the bath rooms are of sheet metal and in the corner of each bath room is a sheet metal locker in which clothing may be hung without danger of wetting it while bathing. A shower bath is not provided, but hot and cold water are supplied and there is a small bench or seat in each bath room on which a tub is placed holding two or three pails of water. The bench is made with a lid and after bathing the tub can be removed and the lid raised, providing a dry seat for the bather to use when dressing. This is a small detail but one of considerable importance to the man, if he wishes to emerge with dry clothes.

The floor of the main room and of all the bath rooms is of cement, but each bath room has a wooden grating making a comparatively dry floor on which to stand at all times.

* * *

A study of advertising schemes and devices, especially those to be seen in a great city, is interesting and instructive. Great sums are often spent in placing pictorial "ads" on the dead walls that will be exposed to public view only a few weeks at most before a new building on the adjacent lot will cover it. This seems like an extravagance, but it must be remembered that thousands see a display in such a position every day, whereas the same might be shown in a less thickly populated section for years before as many would be impressed by it, and that is, of course, what counts. Again novel locations are chosen that are effective because of the elevated position of so many of the dwellers in a great city. Ordinarily no one would think of painting a business sign on the top of a moving van to advertise the business of the owner, but in the city such a sign is fully as advantageously placed as those on the side of the vehicle.

* * *

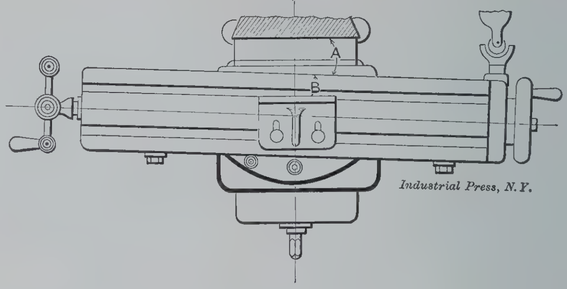
Another aluminum solder recently made public by the issue of patent privilege, is composed of aluminum, 5 parts; antimony, 5 parts; and zinc, 90 parts. The aluminum is first melted and then the zinc is added after which the antimony. The alloy is thoroughly puddled with sal-ammoniac until the surface is clear and white. It is then poured into bar moulds, making it ready for use.

TOOLS AND METHODS FOR ACCURATE THREAD CUTTING.

JOS. M. STABEL.

Thread cutting, as a general thing, forms but a small part of a machinist's daily labor and as the average class of such work is accomplished in a very satisfactory manner, it may seem that little need be said regarding improvements upon present methods. If, however, one should stray away from the regular line of work and undertake making thread plugs, rings, taps, etc., he would find that there is a vast field open for improvement and he would no doubt appreciate a few suggestions from one who has had considerable experience in this class of work. Accurate thread cutting seems to be one of the trade secrets which is not easily mastered or often found described in books. When a man has established his method of accomplishing this work he generally holds on to it tight as he can, and he can hardly be blamed for so doing, since it requires a great deal of time and patience to secure satisfactory results. At the same time this man is wishing he knew the method employed in other shops and often fails to see the reason it is not made public.

FIG. 1. TABLE OF ANGLES USED WHEN MAKING THREAD CHASERS.

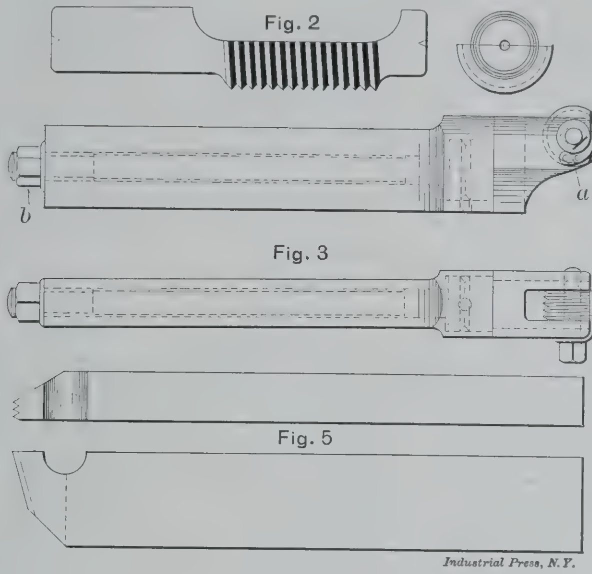


Threads per inch	Angle B in Degrees and Minutes.																Angle A	
	Deg.	Min.	Deg.	Min.	Deg.	Min.	Deg.	Min.	Deg.	Min.	Deg	Min.	Deg.	Min	Deg.	Min.	Deg	Min.
8	..	...	..	...	3	02	2	17	1	49	1	31	1	18	1	08	2	17
10	..	...	3	38	2	26	1	49	1	27	1	13	1	02	..	55	1	49
12	..	...	3	02	2	01	1	31	1	13	1	00	..	52	..	46	1	31
14	..	...	2	36	1	44	1	18	1	01	..	52	..	44	..	39	1	18
16	..	...	2	17	1	31	1	08	..	55	..	46	..	39	..	34	1	08
18	..	...	2	02	1	21	1	00	..	49	..	40	..	35	..	30	1	00
20	3	38	1	49	1	13	..	55	..	44	..	37	..	31	..	27	..	55
22	3	19	1	39	1	06	..	50	..	40	..	33	..	28	..	25	..	50
24	3	02	1	31	1	00	..	46	..	37	..	30	..	26	..	23	..	46
26	2	48	1	24	..	56	..	42	..	34	..	28	..	24	..	21	..	42
28	2	36	1	18	..	52	..	39	..	31	..	26	..	22	..	19	..	39
30	2	27	1	13	..	49	..	37	..	29	..	24	..	21	..	18	..	37
32	2	17	1	08	..	46	..	34	..	27	..	23	..	19	..	17	..	34
36	2	02	1	00	..	40	..	30	..	24	..	20	..	17	..	15	..	30
40	1	49	..	55	..	37	..	27	..	22	..	18	..	16	..	14	..	27
48	1	31	..	46	..	30	..	23	..	18	..	15	..	13	..	12	..	23
56	1	18	..	39	..	26	..	19	..	16	..	13	..	11	..	10	..	19
64	1	08	..	34	..	23	..	17	..	14	..	12	..	10	..	08	..	17
80	..	55	..	27	..	18	..	14	..	11	..	09	..	08	..	07	..	14
100	..	44	..	22	..	15	..	11	..	09	..	07	..	06	..	05	..	11
	¼″		½″		¾″		1″		1¼″		1½″		1¾″		2″			
	Diameter on which chaser is to be used.																	

NOTE.—All hobs to be 1 inch in diameter right-hand thread. Clearance on chasers, 15 degrees.

The writer has seen and done considerable of this work, and although the methods may not be wholly new they may be of interest to many of the readers of MACHINERY. While the method of making thread chasers was employed by Pratt & Whitney several years ago, the writer has never seen it described, and the tables shown in Fig. 1 and the style of hob and fixture for grinding same are original with him. That old saying "Patience is a virtue," is well recognized when doing this class of work. What can be more exasperating than to have a thread tool tear when on the finish cut, or, having made a nice plug and ring gage, to have the ring contract and the plug expand in length when they are hardened? There are any amount of such difficulties in the path of the thread gage and tap maker. That one little item, of the thread tool tearing the threads is greatly, if not wholly, overcome by adopting a chaser in place of a regular V thread tool, as the chaser has three to five threads which tend to keep it from tearing into the work. The chaser is also far superior for cutting U. S. standard threads, as the flat top and bottom are sure to be perfect and can always be held to a standard with the aid of a master hob.

To make a chaser accurately is no small job, although quite simple when properly understood. The first thing is to make the hob, which is shown in Fig. 2. This requires great care as upon it depend all the threads of that certain pitch. The hobs are all made one inch in diameter, this size having been adopted so that the set of tables in Fig. 1 could be formulated. To accurately cut the hob the tool shown in Fig. 3 is utilized. This consists of a small circular thread chaser held in the body of the tool, the forward part of which is made separate from the shank so that it can be swiveled to suit the angle of the thread on the hob. A small piece of steel, *a*, serves as a gage for the cutting face of the circular chaser, so that it can be sharpened and re-set in the holder without disturbing the body of the tool. The nut *b*, on the end of the holder, serves to hold the forward part of the tool securely. After the hob is threaded it is milled out (as shown in Fig. 2) to its center line and then hardened. The object in milling it in this fashion is that it can be easily sharpened by grinding across the face, and this face is also utilized when setting the hob to its proper angle in the milling machine.



The Hob and Chasers.

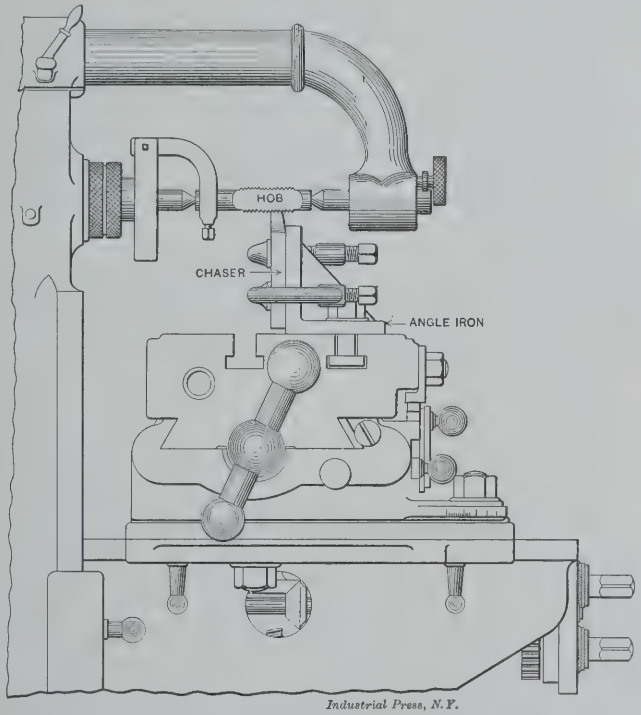


Fig. 6. Milling Machine arranged for Hobbing Chaser.

The sharpening of the hob is accomplished with the special fixture shown in Fig. 4, which is simple in design and is made for use on a surface grinder where it is located so that its centers are at right angles with the emery wheel. The most essential point in grinding a hob of this description is to always grind the cutting face radially, in other words, the lower edge of the emery wheel must be in line with the center of the hob. To accomplish this is employed the little device in the shape of a lever, marked *a*, which has its fulcrum on the block *d* while its other end extends to the forward block upon which are graduated a few lines, about .05 inch apart, each division equaling a movement of .001 inch at the ball *b*. To set the emery wheel, the rear center *c* is removed from the block *d* and the emery wheel, at rest, is brought down onto the ball *b*. The table of the grinder is run to and fro by hand so that the wheel will pass over the ball thus forcing down the lever until it registers at zero, which denotes that the lower edge of the wheel is in alignment with the centers of the fixture. The center *c* is then put back in position and the hob, held by a dog, is placed between the centers and with the aid of the handle *e* is fed around, after each cut across the face, until it is sharpened. At no time during grinding is the perpendicular adjustment of the wheel altered. The ball *b* is a running fit in the lever *a* and on a small pin through its center.

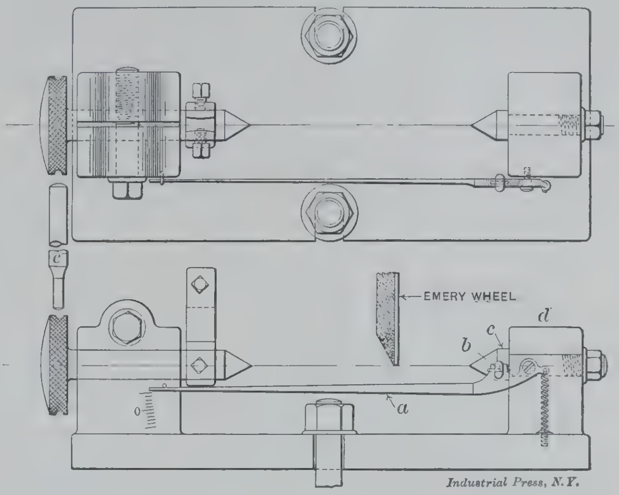


Fig. 4. Fixture for Grinding Hob.

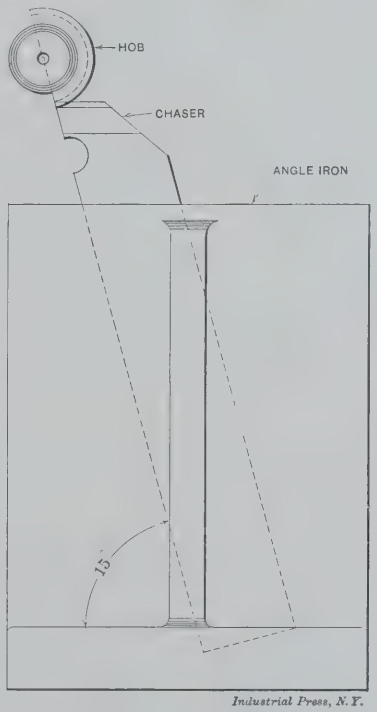


Fig. 7. Hob and Chaser in Position for Hobbing.

The hob being completed, the next step is to make, by use of the hob, the chaser shown in Fig. 5. This is made of tool steel, hand forged, and planed on all sides. It has a cutting clearance of 15 degrees and is placed against an angle iron which, in turn, is held on a milling machine table. The hob is held between the centers of the machine spindle and the overhanging arm, as shown in Fig. 6, and when the cutting edge of the hob is accurately located the spindle is locked in position by means of a wooden wedge which is tapped in between the cone and the frame of the machine. The cutting face of the hob and the body of the chaser stand in a straight line and at an angle of 15 degrees with the table of the machine, as shown in Fig. 7. The most essential point in setting up the machine for this job is to get the angle iron located on the table of the machine at the proper angle for the threads to be shaped on the chaser; as a chaser made to use on a ½-inch tap will not work properly on a 2-inch tap of the same pitch because the angle of the thread is greater on the former than on the latter. The milling machine table has also to be swiveled around to the proper angle of the thread on the hob, as the longitudinal movement of the table must correspond to the thread angle. For this purpose we make use of the table shown in Fig. 1. The plan view used at the head of this table will serve to illustrate the use of same. This is a plan of the milling machine table, showing it swiveled around, and also the angle iron set in the proper position. As will be seen, the table sets at an angle *A*, which is given in degrees and minutes in the right-hand column of the table, while the angle iron is placed on the table of the machine, making with the edge of the table the angle *B*. This is the proper angle for the threads on the chaser. Should it be desired to make a left hand thread chaser the angle iron would be placed at the same angle called for by the table but in the opposite direction.

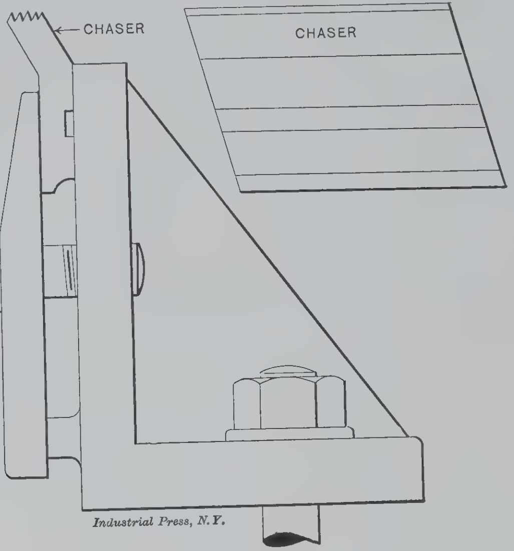


Fig. 8. Fixture for Hobbing the Pratt & Whitney Chaser.

As an example, we will suppose that it is desired to make a chaser that is to be used in making taps ½ inch in diameter having 26 threads per inch. We first look in the "threads per inch" column until we come to 26, then by following along the line we come to the last column, which gives us the angle at which the milling machine table is to be set, or the angle *A*, which equals 0 degrees and 42 minutes. On the lower edge of the tables are the diameters on which the chasers are to be used and as in this case we have ½ inch, we follow up that column to the 26 pitch line, where we obtain the angle at which the angle iron is to be located on the table of the machine, or angle *B*, which in this case is 1 degree and 24 minutes. The machine being properly set, it is a small matter to shape the thread by moving the table to and fro and gradually feeding it upward until a perfect thread is obtained on the chaser. It is advisable to keep the hob well lubricated when cutting to insure a smooth thread on the chaser. A very good lubricant for this purpose is a mixture of one-half turpentine with one-half good lard oil. This will also be found an excellent lubricant for general thread cutting in the lathe.

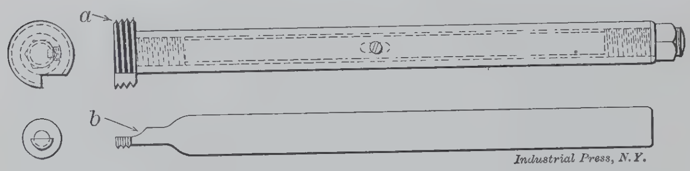


Fig. 9. Chasers for Internal Threads.

Another style of chaser which has proved itself very useful may be worthy of notice. This is what is known as the Pratt & Whitney chaser, which is shown in Fig. 8. It is made separate from the body of the tool holder, in the angle iron shown in the same figure. For inside thread cutting the two tools shown in Fig. 9 can be used very handily. The one marked *a* is for large inside diameters and is composed of a tube through which runs a rod, threaded on each of its ends. Upon the front end is screwed a circular chaser which is held firmly against the tube by a nut on the other end of the rod. This makes a very handy device when chasers have to be changed, for by loosening the nut on the end, the chaser can be easily removed with the fingers. The solid chaser, *b*, shown in same figure, is for use on holes of small diameter the threaded part being milled half off. When sharpening this chaser care must be taken to always grind the face radially in order to insure accurate results.

* * *

THE BURSTING OF EMERY WHEELS*.

Several years ago the writer was consulted regarding some points of a case in litigation occasioned by the bursting of an emery wheel and the resulting death of a workman. The question to be decided was whether the wheel was unsafe at the speed recommended by the makers, or whether the accident was due to the carelessness of the operator.

As it was just then an "off" year for experiments on flywheels there seemed to be no good reason why the same medicine could not be tried on emery wheels. The apparatus already described in former papers read before this Society, with some slight alterations, was adapted to the new requirements, and in the spring of 1902, fifteen wheels of various makes were tested to destruction.

TABLE.

No. of Test.	Grade Mark.	No. of Emery.	Working Speed.		Bursting Speed.		Speed Ratio.	Factor of Safety.
			Revs. per Minute.	Feet per Minute.	Revs per Minute.	Feet per Minute.		
1	4 5	20	1,200	5,030	3,100	13,000	2.58	6.67
2	4.5	20	1,200	5,030	3,200	13,400	2.67	7.14
3	4.5	20	1,200	5,030	3,350	14,020	2.79	7.73
4	Q	30	1,250	5,230	3,750	15,700	3 00	9.00
5	Q	30	1,250	5,230	2 750	11,500	2.20	4.84
6	H	30	1,400	5,870	4 550	19,050	3.25	10.56
7	H	30	1,400	5,870	4,600	19,200	3.28	10 76
8	O	36	1,250	5,230	4,100	17,200	3.28	10.76
9	O	36	1,250	5,230	4,125	17,250	3.30	10.89
10	2 5	60	1,150	4,830	2,750	11,500	2.39	5.71
11	2.5	60	1,150	4,830	2,900	12,100	2.52	6.35
12	M. H.	14	1,200	5,030	3.100	12,970	2.58	6.66
13		24	1,200	5,030	3,800	15,900	3.17	10.00
14	H	10–12	1,200	5,030	4.100	17,200	3.42	11.70
15	H	10–12	1,200	5,030	4,350	18,200	3.62	13.10

Tests 6 and 7; wheels made with wire netting; tests 14 and 15, with vulcanized rubber.

For the actual details of the work credit is due to Messrs. Chandler and Krueger of the class of 1902, Case School of Applied Science. Most manufacturers of this class of wheels test them for their own information, but the results are not generally given to the public; the writer knows of no published data on this subject. At the Norton Emery Wheel Works, all wheels are tested before leaving the shop at a speed double that allowed in regular service, and occasionally wheels are burst to determine the actual factor of safety.

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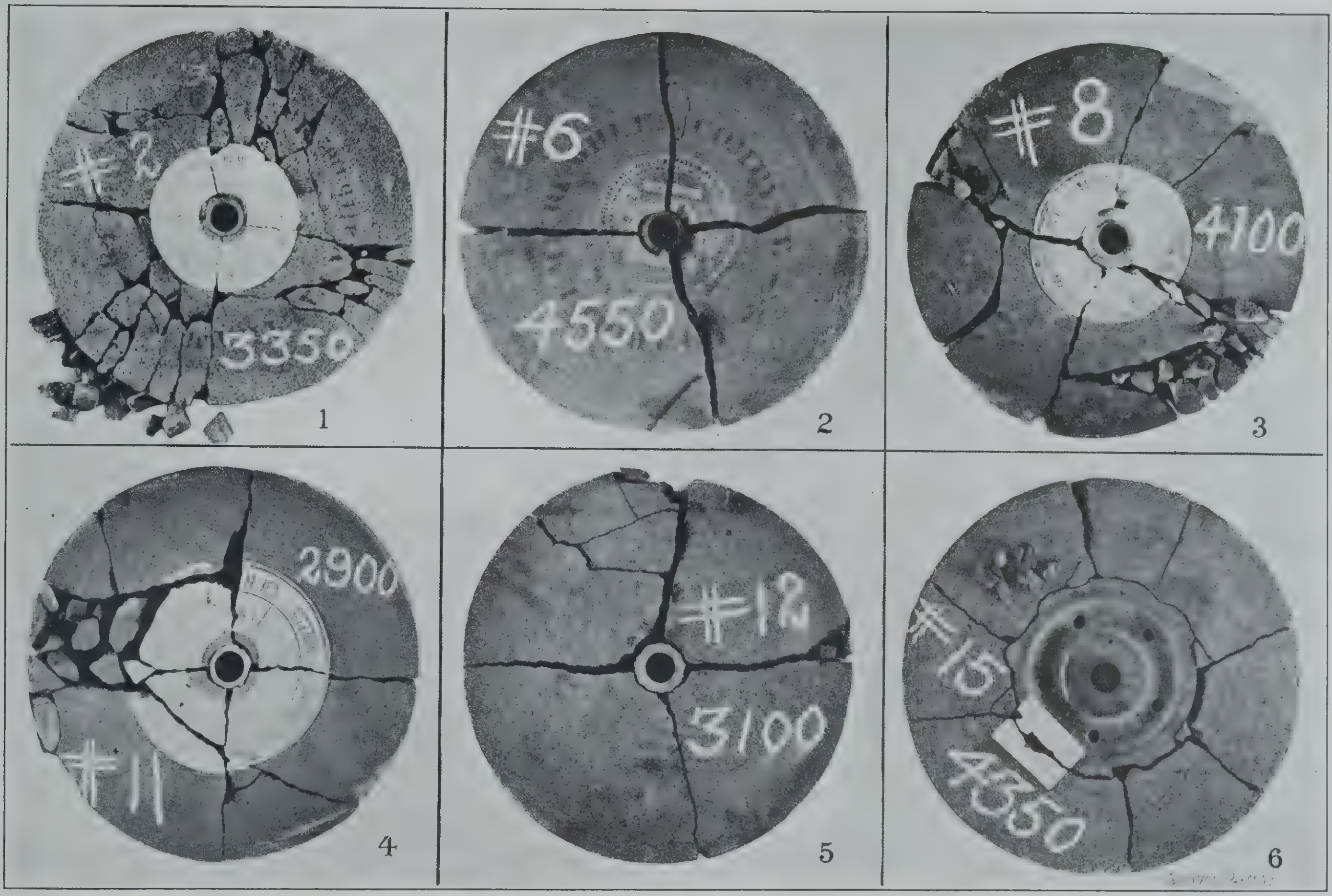
* Paper read before Saratoga Convention of A. S. M. E., by Prof. C. H. Benjamin.

Emery-wheel accidents are not uncommon, but can usually be traced to the carelessness of the operator. One common cause of failure is allowing a small piece of work to slip or roll between the wheel and the rest. The writer was once present on an occasion of this kind, and although he fortunately was not in the plane of rotation, he has never forgotten his sensations.

The wheels selected for the experiments were all of the same size, being sixteen inches in diameter by one inch thick, and having a hole one and one-quarter inches in diameter.

The object of the experiment being to determine the bursting speed of such wheels as are actually on the market, emery wheels were obtained through various outside parties without indicating to the agents or manufacturers the use to be made of them.

In this way wheels of six different makes were obtained, the label on each wheel showing usually the maker's name, the grade number or letter, the quality of emery, and the speed recommended for use. As shown in the table of results, the working speed varied in the different wheels from 1,150 to 1,400 revolutions per minute, the average being about 1,200 revolutions per minute. For a diameter of sixteen inches this corresponds to a peripheral velocity of about 5,000 feet per minute. The table also shows that the fineness of the emery varied from ten to sixty, the average being about thirty.



Results of Experiments on Emery Wheels.

The wheels were held between two collars, each six and one-eighth inches in diameter and concaved, so as to bear only on a ring three-fourths of an inch wide at the outer circumference.

The method of testing, and the apparatus used were precisely similar to those described in the paper on "The Bursting of Small Cast-iron Flywheels," by the author at a previous meeting, to which reference is made for illustrations of the apparatus.

The table shows the results of the experiments in detail, and needs but little explanation. The illustrations, Figs. 1 to 6 show characteristic fractures, and the appearance of various wheels after bursting.

Wheels numbered 1, 2, and 3, were of one make, and show a remarkable uniformity in strength. (Fig. 1.)

Nos. 4, 5, 8, and 9 were all made by one firm; the two latter wheels were of finer grain than the others, and show a correspondingly greater strength. (Fig. 3).

Nos. 6 and 7 contained a layer of brass wire netting imbedded in the emery, and were about one-third stronger than the average of the ordinary wheels. (Fig. 2.)

The wheels numbered 10 and 11 were the weakest among those tested, but have an apparent factor of safety of between five and six. (Fig. 4.)

Nos. 12 and 13, of still another make, burst at about the average speed. (Fig. 5.) Wheels Nos. 14 and 15 were so-called vulcanized wheels, containing rubber in the bond, and intended for particularly severe service. These showed, as was expected, rather more than the average strength. (Fig. 6.)

An examination of the last two columns in the table shows that the wheels burst at speeds varying from two and one-quarter to three and three-quarters the working speed, and accordingly had factors of safety, varying from five to thirteen.

It is then apparent that any of these wheels were safe at the speed recommended, and would not have burst under ordinary conditions. At the same time, considering the violent nature of the service and the shocks to which they are exposed, it would seem that the factor of safety for emery wheels should be large. In comparison with those generally used in machines, a factor of eight or ten would seem small enough.

It may also be said that such a variation in strength between wheels of the same make and grade, as for instance, that between Nos. 4 and 5, indicates a lack of uniformity which causes distrust.

The fractures were in the main radial, as may be seen from the cuts, the wheel splitting in three, four or five sectors as might chance.

It may be assumed that these radial cracks started from the rim where the velocity and stress were greatest, but it is a fact worthy of notice that in nearly every instance the cracks radiated from points where the lead bushing projected into the body of the wheel.

ENGINE AND BOILER TESTING.

W. H. BOOTH.

There are two or three different sorts of tests usually made on steam plants. First, there is the elaborate test with a score of observers and a high priest who sits in an arm chair and blows a whistle every ten or fifteen minutes as a signal to read instruments. I have observed that these tests usually give results out of all reason; too good to be believed. Then there is the test of the charlatan, whose results are of over 100 per cent. efficiency. Finally, there is the test made by ordinary engineers, who neither look for nor expect to obtain extraordinary efficiencies, and who have to hold the balance between buyer and seller without too hard-and-fast ruling on either side, but with fairness to both. Usually such tests cannot be made under the specified conditions, and allowances must be made both ways to allow for differences. In making such allowances, both sides must feel a confidence in the ability and good faith of the testing engineer, who must not be finical in his adherence to minutiæ, but must be able to form fair judgments in case of variation from specified conditions. It is open to question whether there be not at times too great elaboration in making tests, especially when it is a case of teaching students at a technical school where ideas of testing may be so biased as to be injurious to him in his future career.

It is advantageous for the students of a technical college to have the now usual experimental engine fitted with all manner of appliances upon and with which to make tests. But the elaborating of appliances does not always tend to make the student resourceful. I have observed in engineers brought up in shops of the highest class a lack of ability to devise means of getting over difficulties when dropped down in some backwoods kind of place away from appliances. Accustomed to the facilities of a big shop, there would be felt the absence of the overhead traveler, and the job of getting a boiler or heavy piece of machinery over a ploughed field or across to its place on a difficult foundation would be more easily carried out by the apprentice from the little shop. Similarly, high-class experimental engine testing cannot be carried into practice, and this is where the mischief of the experimental work comes in. In far too many cases the principal use of the experimental engine is the advertising of the professor. With an expensive tool purchased at public expense and an unlimited set of instruments, and a staff of students eager to take readings, very elaborate and full data can be obtained and these are published and serve to advertise the professor, who in this way gradually works himself up into a good practice as consulting engineer. Meanwhile, being conducted on an engine by no means of ordinary build or arrangement the figures and conclusions are apt to be of very small value. Further, they are apt to mislead students and it is probable that a cheap engine of less elaboration would tell more in the long run. It would be better that the subject of engine testing should be taught somewhat differently. The engine might be a plain one of commercial type and entirely free of appliances for testing. Then let the students begin from the beginning and devise the means of driving the indicator. Let them apply two indicators, or rather three—it will be good practice for them to test them for equality—one upon a pipe common to both ends of the cylinder and the other two on short connections. This will show them the effect of the pipe connections. On similar lines they should be taken all through, using such apparatus as can be roughed out. A great art in testing is to obtain good results from poor appliances, and when tests are to be made it is with poor appliances one has usually to work. Water supply for example is oftener drawn from a tank of large area and demands care in depth measurements. Weighing is better, but cannot be done. In order to keep as unbiased a mind as possible it is a good plan to leave out the tank area measurement until the depth of water used up has been ascertained. This tank measurement should, of course, be made with a rod and upward point. It is easier to see when a point breaks the surface of water when coming up from beneath such surface than when pointing down from above, as in the latter case capillarity interferes with accuracy.

In what may be termed ordinary testing the engine will be doing its regular work. It will not be grinding upon a brake and careful indicating will be necessary. There can be no comparison attempted between indicated and brake horse power. It will sometimes happen that engine testing will be found exceedingly painful and disagreeable. There is an inventor to be dealt with, and the testing engineer will have in his hands the making or marring of the man's fortune. It has been known that tests have been called for by promoters with the sole object of publishing the results, and all kinds of subterfuges have been resorted to in order to influence the results. In cases of this kind it is necessary to keep a very careful eye on the coal weighing, and even the coal pile, and such a test cannot be conducted without a sufficient number of assistants. But where a test is merely made for the satisfaction of the man who owns an engine and foots the coal bills and the intention of everyone is honest, an engineer by himself may, by working hard, obtain results of sufficient accuracy entirely unaided except by the ordinary staff. The fireman will himself weigh out the coal, and though he would probably make an error in counting the weighings he is not likely to make an error if with each barrow of coal he brings a tally in the shape of a marble or a chip of wood and deposits it in a basket in the boiler house. Such a test involves as its chief labor a large number of indicator diagrams, but I have known tests so carried out on a compound engine by means of one instrument only, the spring being changed every time the instrument was moved from cylinder to cylinder. No system of indicator test can be of any great value where loads are uneven, but they may be relied upon for such uniform and steady loads as occur in textile mills or flouring mills, where a full average load is carried all the time and any variation will be due to a gradual change of load, such as might arise from alteration in the efficiency of lubrication from a change of temperature. In a textile mill it is usual for the Monday morning load to be the maximum for the week. Machinery is cold, oil stiffened and lubrication deficient and these causes bring up the turning power for a time. The effect of different lubrication is very marked. Before mineral oils were so common the usual lubricant in an English cotton mill was sperm oil, which cost, if I remember rightly, about $2 per gallon. Sperm oil was undoubtedly good. It did not gum, and it flowed freely, and worked well with the light spinning spindles, but the growing scarcity of the cachelot whale rendered its oil liable to be adulterated and it was very costly. Mineral oil at half a dollar per gallon (10 lbs.) is now spoken of as expensive. A mill owner who had used nothing but sperm oil informed me that he had been making experiments with other oils, and on a total horse power of about 300 he had detected a difference of 20 horse power by an admixture with the sperm oil of half mineral at about half price. Mineral oil was then dearer than it is now. Any other mixture than half and half gave less good results. Thus by reducing the net cost of oil by one fourth he would save a considerable weight of coal, probably with his poor engine, 100 pounds per hour. Since high-speed engines for electrical working have become so common we have become accustomed to read very elaborate papers on steam economy and the professional element has been having a fine fling with elaborate tests. Now I have seen some of these high-speed engines run and I have been compelled to observe the exceedingly busy manner of the oil can and it has occurred to me that the time has arrived for some kind of tests to be made upon the oil consumption of modern steam engines. Oil costs about $100 per ton, one may say, or from 30 to 80 times as much as coal. In saving a ton of coal we must be careful it does not involve us in too many decimals of a ton of extra oil. With all the elaborate testing of the past few years and the loud talk about improvements and experiments, there is a continual tendency in practical construction to degenerate in respect of such details of construction as experience has shown to be necessary to durability and comfort. Now it costs no more properly to set a boiler to the plans which have been evolved by years of experience in the faults of older methods, and have been gathered together by quite an army of inspectors. Yet if a boiler be set without the supervision of experts it will assuredly be set on lines which are more or less retrograde and when this boiler comes to be worked it will not be so fully open to inspection as it ought to be. In England the standard boiler is the Lancashire type. As regards its brick setting this boiler is a cylinder 28 to 32 feet long, and 7 to 9 feet diameter. Its approved method of setting is such that though there are three longitudinal brick work external flues, involving four lines of contact of brickwork, every portion of the shell is visible to an inspector, and this result is secured simply by the use of properly formed firebrick seating blocks, which, while allowing of thorough inspection do not admit any serious leakage of gases between flue and flue. In old times the supporting walls of a boiler sometimes had a contact width of a couple of feet and any amount of corrosion due to possible leakage or damp foundations would take place out of sight until finally the boiler exploded unless it was so lucky as to spring a serious leak before being so much eaten away as to explode. Testing is all very well when carried out in a sensible manner, but it can only show shortcomings, and proper attention would often prevent the necessity of test. Our aim should be to construct upon the best lines. Attendants would then have no excuse for falling short in their upkeep. I have known a careful engineer with old engines and 60 pound boilers obtain his power for 2¼ pounds of coal per I. H. P. hour and he did this entirely by careful attention and upkeep, and out of the above fuel he warmed the mill and boiled some water for trade purposes. This man paid very particular attention to all vacuum joints and secured every possible ounce of vacuum that it was possible to get. He painted all pipes which inclosed a vacuum to close their pores, and he was careful with glands and packings, and with his firemen. Greater economy is possible with higher pressures and best conditions, but it is not so easy to maintain engines in order at high pressures, and without special care a modern engine may easily fall below the economy of a low pressure plant, thoroughly cared for. No man in charge of an old plant should allow this fact to excuse him of carefulness. "If only I had a new plant," he will complain, "I could do so much better." Now an old plant, if sound, is really more comfortable to attend and may be gotten up by care to a very high efficiency and kept there, too, with far less trouble and anxiety than can a modern high pressure plant, and it is likely to cost very much less in oil and incidentals.

* * *

THE UNIVERSAL TECHNICAL DICTIONARY OF THE SOCIETY OF GERMAN ENGINEERS.

In the beginning of 1901 the Society of German Engineers (Verein Deutscher Ingenieure) began the compilation of a universal technical dictionary in the three languages English, German, and French. This undertaking has met with general approval and has received assistance from all quarters at home and abroad. Societies and individuals have responded generously to the invitation to collaborate and have proved their interest by the transmission of collections of technical words made by them or by promising such in the near future. There are now 341 societies (42 in English, 272 in German, and 27 in French speaking countries) co-operating in the work, and through these societies the Technolexicon has found helpers in Great Britain, Germany, France, the United States, and other countries.

Of the American societies may be mentioned the American Society of Civil Engineers, New York; the American Society of Mechanical Engineers, New York; American Railway Engineering and Maintenance-of-Way Association, Chicago; the American Chemical Society, Brooklyn; the Western Society of Engineers, Chicago, etc. Assistance has so far been promised by 2,185 industrial establishments and individual collaborators, many of which are in America.

For convenience's sake the Society of German Engineers has provided handy note-books (each with 3 indices A—Z) for the collaborators to write their collections therein. These books will be called in by the editor-in-chief in the course of 1904. So far 207 filled-out note-books have been forwarded voluntarily to the office at the address given herewith.

As the contributions will not be called in before 1904, all who wish to help in the compilation of the Technolexicon have still time and opportunity to assist in the preparation of their specialties. Contributions from all technical branches are welcome and it is obvious that small contributions from a host of various collaborators will be more useful than large ones compiled by a few men, who naturally cannot cover so many specialties. Attention is to be drawn to the fact that contributions in only one language are also most acceptable, though of course those in two or three languages are the most valuable. Delayed contributions, if they arrive before the end of 1906, when the printing will begin, can still be used.

The editor-in-chief will be pleased to give any information wanted. Address: Technolexicon, Dr. Hubert Jansen, Berlin (NW.7), Dorotheenstr. 49.

* * *

SCHOOL TRAINING AND PRACTICAL EXPERIENCE.

A paper was read by P. M. Lincoln upon "The Training of the High Tension Engineer" before a recent convention of the Canadian Electrical Association, which contained some very good comparisons of the parts played by college and by practical experience in the making of a man versed in high-tension electrical work. He said:

The college instructs in those methods of doing things which have become standard by universal adoption. The college teaches positive knowledge. In the school of experience on the other hand, one is more apt to learn how not to do it, and by the elimination of the unsuccessful, arrive at the goal of success. The knowledge gained by experience is more often negative.

Put to the fresh college graduate the problem of the amount of distance to be left between the conductors of a high tension transmission line. His answer will involve most likely the jumping distance of the voltage to be used, the length of span, the sag and perhaps a liberal factor of safety. It is experience only that will show that his premises are wrong and that the equation to determine spacing of high tension wires depends very little on the voltages to be carried and almost entirely on such things as the average length and ohmic resistance of cats, the spread of wing of owls and cranes and eagles, and the average length of scrap baling wire, together with the strength of the average small boy's throwing arm.

The experiences of to-day are incorporated into the text books of to-morrow. But, although the result of experience may be taught to the college student—allowing always for a considerable angle of lag—the college curriculum can never become the substitute for the school of experience.

But it is furthest from my thoughts to cast any slur upon the technical graduate. I look back upon my own course in electrical engineering and feel that it is the most valuable asset I ever possessed. The technical course is the best of foundations, but it is only a foundation. The end of the college course is rightly called "Commencement." The great advantage of the technical education is that it gives the man proper equipment for overcoming the difficulties with which his experience is bound to bring him into contact. There is nothing like the college education to equip a man for making every accident a lesson in "how not to do it," and every failure a stepping stone to success.

* * *

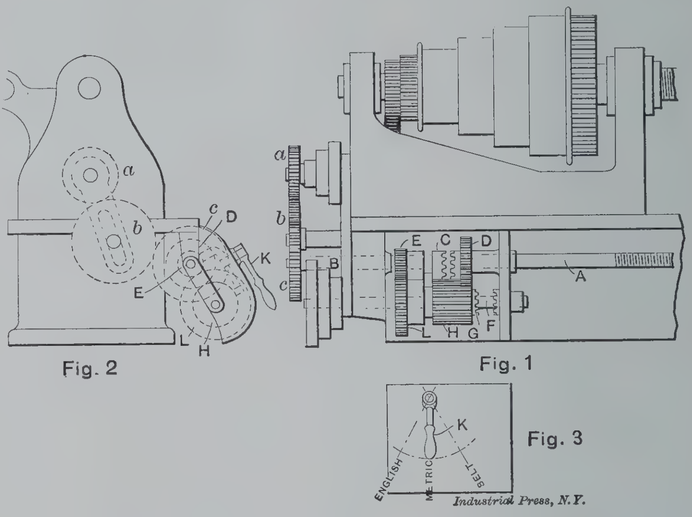
The growing use to which concrete construction is being put in engineering work is a matter of general knowledge, but the use of molten slag for making foundations is something that is known only in the vicinity of iron and steel plants. It would be difficult to find a more solid and enduring material for such purposes. James Christie in the discussion following the reading of a paper by Charles Piez, "Handling and Storing Iron Ore," stated that the foundations of the cantilever cranes of the Penn Iron & Coal Co., Canal Dover, Ohio, which are near blast furnaces, were made by digging trenches extending the whole length of the structure and filling them with molten slag. The concrete walls that support the traveling cantilevers, therefore, rest on immense monoliths of slag. A new steel mill was recently built by the United States Corporation near Pittsburg, Pa., on what was formerly a swamp, but which had been utilized as a slag dumping ground. The soft yielding surface was thereby transformed into an adamantine solid on which the heaviest machinery could be set with surety as to the permanence of foundations.

THE EVOLUTION OF THE CHANGE GEAR.—2.

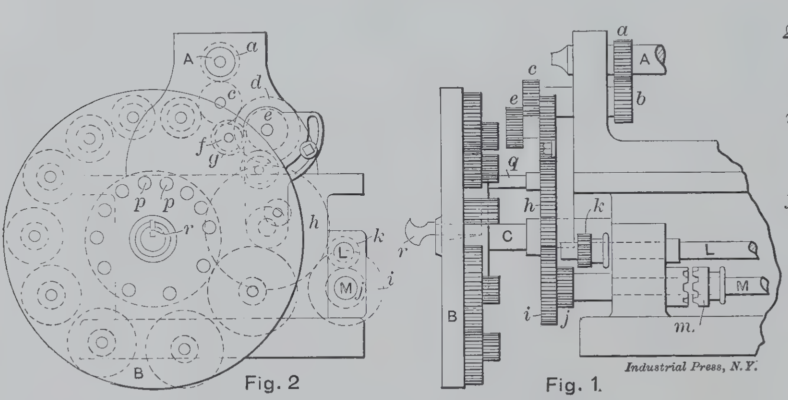
OSCAR E. PERRIGO.

The Patent No. 525,863, granted September 11, 1894, to Salmon W. Putnam, of Nashua, N. H., in so far as it related to cutting threads was for the purpose of cutting either the English or the metric standard threads without removing a change gear. It is represented in the drawings Fig. 1 showing a front, Fig. 2, an end elevation, and Fig. 3, the shifting lever by which the lathe is adjusted for English or metric threads or for a belt feed. The device consists of a lead screw in two parts, *A* and *B*, which may be connected by a clutch *C*, the toothed part of which is splined on that portion of the screw projecting through the head of the lathe and the other part formed upon the gear *D*, fixed on the portion of the lead screws threaded in the usual manner. Both the gears, *E* and *D*, engage a double gear *H*, splined on a short feed rod *F* (not extending to the apron). Fixed on the feed rod *F*, is one portion of a clutch *G*, formed upon the double gear *H*, having the gear *L*, formed upon it, the other portion being formed upon the bracket *J*, in which the rod *F* is journaled. The usual feed cone is also fixed upon the feed rod. These clutches were operated simultaneously by a lever *K*, which, standing in the position shown, enabled the lathe to cut metric threads. With the upper clutch *C* closed, English threads were cut. With the lower clutch *G* closed the usual belt feed was obtained, through the lead screw, upon which a sliding bevel pinion (not shown), operated the apron feed. The device is a compact arrangement for accomplishing the main object sought, that is, to readily change the lathe from English to metric threads and again to belt feed; but whether it would be of such frequent use in the average machine shop as to make its adoption general is somewhat doubtful. It should be said that the regular change gears were applied in the usual way, the device being adapted particularly for the different systems of threads. The lead screw also operated the feed rod.

The first attempt at mounting all the change gears upon a circular plate which might be rotated to successively bring each of the gears into action, is described in Patent No. 536,615, granted to Edward Flather, of Bridgeport, Conn., April 2, 1895. This system requires considerable room at the head of the lathe and thirty-three gears of various sizes, with proper studs, swing plate, fastenings, etc., to cut only twelve different pitches of thread. An arrangement of clutches makes this system of gears also available for driving the feed rod. The inventor mentions some modifications of this plan, which do not seem important and do not materially reduce its large number of gears and other parts. In the drawings, Fig. 1 is a front elevation and Fig. 2 is an end elevation of the invention. From the head spindle *A*, the power is carried through the gears *a*, and *b*, to the gear *c*, which will engage in turn with any one of the smaller of the pairs of gears journaled upon the revolving plate *B*, while the gear *e*, is likewise adapted to engage at the same time any one of the larger of the pairs of gears journaled on the plate *B*. This provides for the change from one pitch to the other, the motion being continued through the gears *h*, *i*, *j*, and *k*, the latter fixed to the lead screw *L*. The revolving plate *B*, is arranged to slide out upon its spindle *C*. This enables the operator to revolve it to any desired position to bring the proper gears into engagement with the driving and transmitting gears, the series of pairs of gears carried by the plate being loose upon their studs and serving as compounding gears of varying ratios when brought into action. The revolving plate is provided with a series of holes *p*, located at proper intervals and engaging the fixed stud *q*, when the plate is forced back to its operative position after being brought to its proper place. It is prevented from working out of place by the spring catch *r*. The gear *k*, is splined to the lead screw *L*, and may be withdrawn from engagement with the gear *j*, when it is desired to drive the feed rod *M*, which is engaged by closing the clutch *m*.

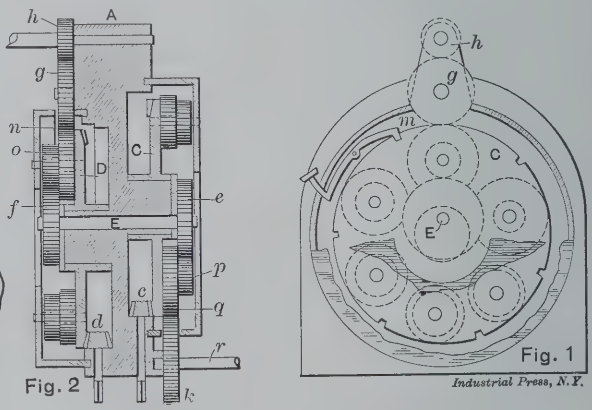


Salmon W. Putnam. No. 525,863, September 11, 1894.



Edward Flather. No. 536,615, April 2, 1895.

Benjamin F. Burdick obtained on April 23, 1895, Patent No. 537,816, in which he introduces a double disk of gears, which are brought into action with the driving gear and the lead screw respectively by pivoting the gear disks or cases eccentrically upon a central shaft. The idea is ingenious and effective, probably as much so as is possible with the arrangement known as the "disk of gears." In the drawing, Fig. 1 is a face view or what would be, when it is applied to a lathe an end elevation. Fig. 2, is a vertical section, showing the eccentric location of the disks. The case *A*, is recessed on each side, the centers of each recess being eccentric with the other. Upon the hubs formed in making these recesses are journaled two gear-carrying plates *C*, *D*, having bevel gear teeth formed upon them, which are engaged by the bevel pinions *c*, *d*, by which they are rotated to any desired positions. Through the center of this case is the transmitting shaft *E*, having fixed upon it the gears *e*, *f*. Each of the revolving disks carries, journaled upon fixed studs, a series of pairs of gears of unequal diameters, fixed together, and capable of being brought into engagement with the transmitting gears *g*, *h*, on the one side and the transmitting gear *k*, on the other, the eccentricity of the centers of rotation being exactly sufficient to do this. Each of the gear disks is held at any desired point by lever *m*, engaging suitable slots in the edge of the disk. Thus, for instance, the motion is conveyed from the lathe by the gears *h*, and *g*,



Benj. F. Burdick. No. 537,816, April, 1895.

through the gears *n*, *o*, *f*; the shaft *E*, the gears *e*, *p*, *q*, and *k*, to the shaft *r*, and thence to the lead screw. By providing two disks of gears the number of changes is multiplied without the same addition of gears which would be required in the device of Edward Flather, last considered. If the disk of gears is to be used at all, the method of locating one or more of them, as desired, in an eccentric position relatively to the engaging gears, so as to conveniently bring either pair of gears into action without the use of catches, sliding movements and similar devices, would seem to be the best method.

It remained for Carl Johan Paulson, a Swede, of Brooklyn, N. Y., to invent an entirely new application of the principle of the cone of gears and traveling pinion, or at least an ingenious modification of it, which is shown in his Patent No. 541,385, dated June 18, 1895. In place of having a series of different sized gears side by side, he places them one within the other in the form of a series of rings, capable of being individually moved out to the position of action, where the teeth cut upon the ring are engaged by a pinion journaled on a swinging arm in the usual manner. In the drawings, Fig. 1 shows a face view of his device, and Fig. 2, a vertical section. In a circular case *A*, provided with a central hub *a*, is arranged a series of rings *b*, *b*, *b*, etc., completely filling the annular space. These rings have spur gear teeth cut upon them as shown at *c*, *c*, *c*, etc. They are prevented from becoming detached by the retaining plate *d*, which, in turn is held in place by the spring *e*. The screw *f*, has cut upon it right- and left-hand threads, upon which are fitted cams *g*, *g*, whose office it is to project the required ring as the cams are brought opposite to it by revolving the screw *f*. The central shaft *B*, is the driving shaft of the device and from either ring gear employed the power is transmitted by the gears *C*, and *D*, journaled on the swinging lever *F*, or vice versa, as may be desired. Each of the ring gears have lugs *h*, *h*, etc., formed upon them by which the whole device is revolved.

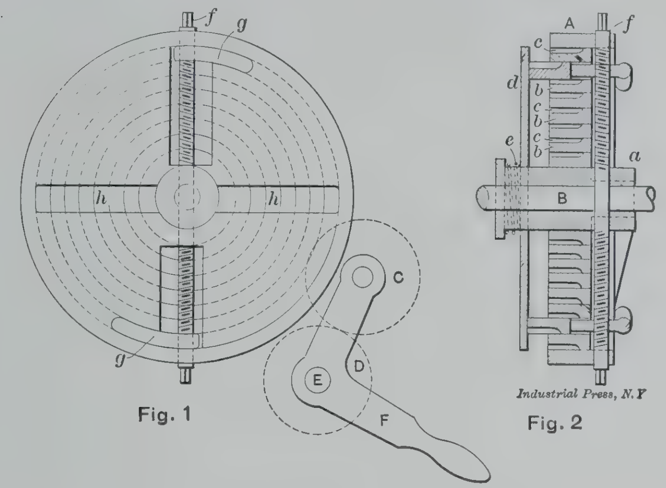


Fig. 1 Fig. 2

Carl J. Paulson. No. 541,385, June 18, 1895.

On November 2, 1897, Herbert L. Flather, of Nashua, N. H., was granted Patent No. 592,966, in which he makes use of the cone of gears fixed upon a supplementary shaft located in the lathe bed. The secondary shaft is parallel to it and has upon it the usual traveler carrying its pinion splined to the shaft, and the intermediate, or traveler pinion journaled in it. The lever by which the traveler is operated and fixed in position is an ingenious device and quite different from Norton's. The cone of gears arrangement is to be operated in connection with interchangeable gearing, much the same as the usual change gears, so that the older method of taking off and putting on gears was not wholly eliminated. In the drawing, Fig. 1, is an end elevation of the device; Fig. 2, is a transverse section of the bed, showing the cone of gears; and Fig. 3 is an inverted plan showing the cone of gears, shifting lever and their appendages. The power is transmitted from the head spindle through the gears *a*, *b*, *c*, to the gear *N*, on the transverse shaft *o*, upon which is journaled the shifting lever *R*, carrying the connecting gear *U*, journaled on the stud *S*. Upon the shaft *E* is fixed the cone of gears *F*, *F*, *F*, etc. (The shafts *E* and *O* are not connected by the gears *G* and *N*, as would appear in Fig. 3, one of these shafts being considerably lower than the other, as will be seen in Fig. 1.) The shifting lever *R*, is controlled in its movements by the guide plate *V*, and held at any desired point by the pin *x*, (actuated by the thumb lever *Y*,) entering the proper hole *w*, in the guide plate *V*. The power is carried on from the cone of gears, through the gears *G*, *H*, and *I*, to the lead screw *D*, and by the gear *T*, to the feed rod *Z*. The gears *G*, *H*, and *I*, are adapted to be changed in the usual manner whenever desired.

Patent No. 595,562, granted December 14, 1897, to Ernest J. Flather, of Nashua, N. H., is somewhat in the nature of a combination of Patents No. 470,591 and No. 519,924, granted to Wendel P. Norton, improved in the general arrangement and with some good points added. In this case the cone of gears, which by this time seems to have become very popular with inventors, is placed upon a short shaft in front of the bed and arranged to drive either the lead screw or the feed rod. In addition to this, the bevel reversing gears of Norton's patent, No. 519,924, are placed on the line of this shaft, to the left of the cone of gears, (and not shown in the drawing) which would seem to be a preferable position. The method of handling the traveling intermediate gear is ingenious and practical. In the drawing, Fig. 1, is a front elevation; Fig. 2, is a transverse section of the cone of gears and appendages; Fig. 3, is a section through the shifting lever and its connecting parts, and Fig. 4, is a perspective view of the same, showing its eccentric pivoting trunnions. The power for driving the lead screw is transmitted from the head spindle through the gears *a*, *b*, *c*, *d*, and *e*, in the usual manner, to the supplementary shaft *D*, upon which the shifting lever frame *K*, is journaled. Within this case is fitted the shifting lever *m*, carrying the connecting gear *h*, meshing into the shifting pinion *k*, on the shaft *D*. The shifting lever *m*, is pivoted upon an eccentric shaft *n*, by which it is brought into position as desired, and is readily dropped out of engaging position when it is desired to shift to any other position. Its position in shifting is guided by the guide *p*, properly perforated for the spring pin *s*. Upon the right-hand end of the shaft *g*, is a gear, (not shown), meshing with the gear *q*, on the lead screw *E*, and driving it. Upon the feed rod *F*, is splined a gear *r*, which may be moved into engagement with the gear *q*, and thus power is transmitted to the feed rod.

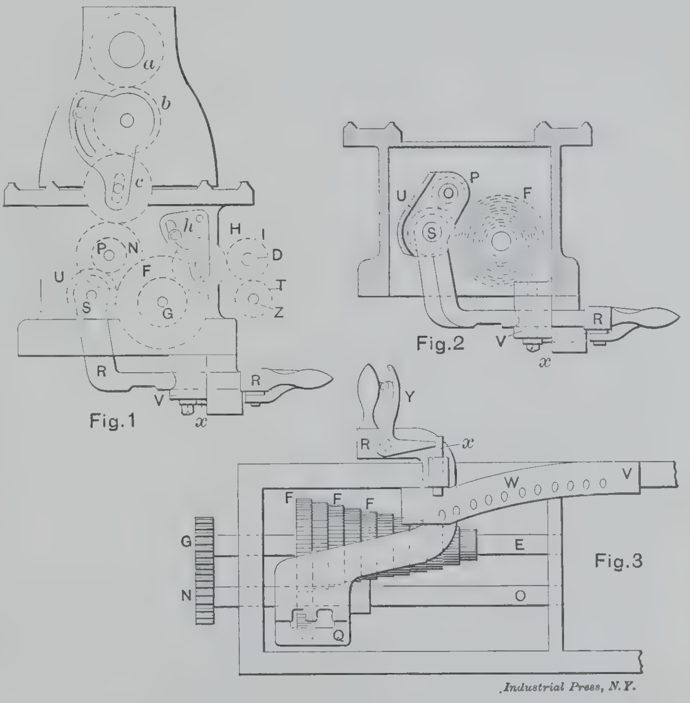
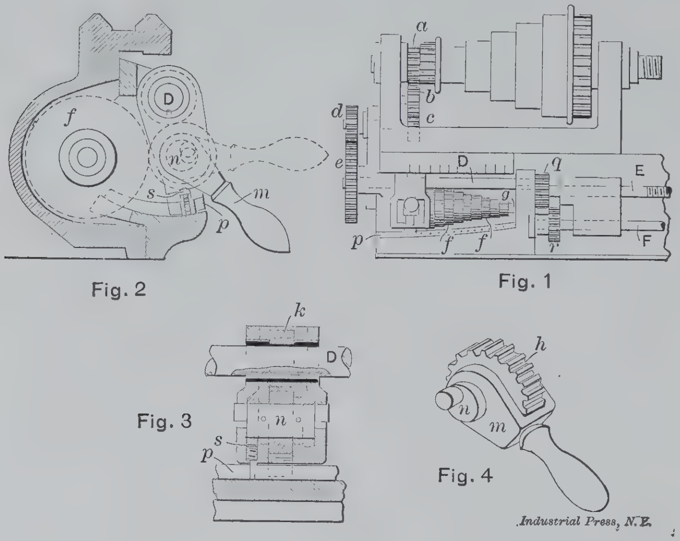


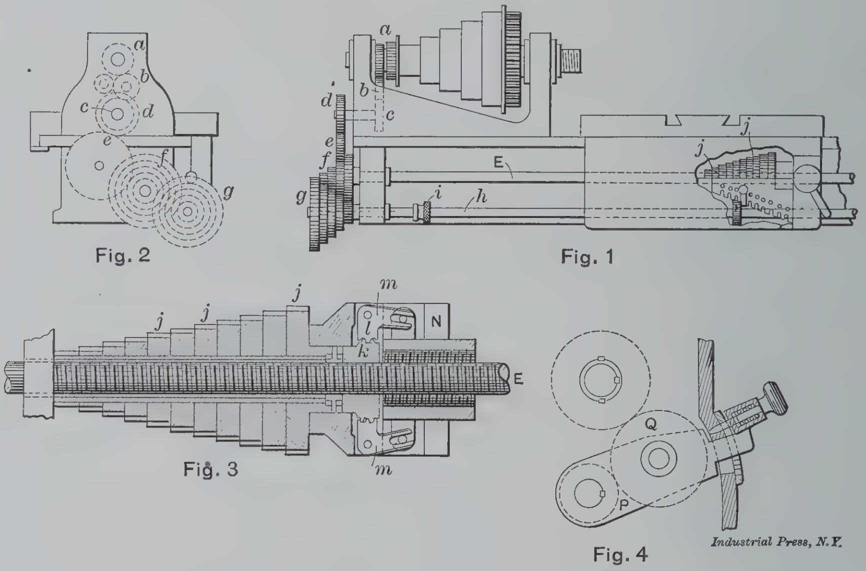
Fig.1 Fig.2 Fig.3

Herbert L. Flather. No. 592,966, November 2, 1897.

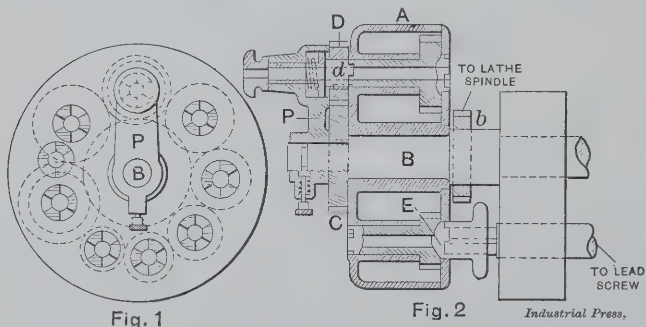
Benjamin A. Wheeler patented, April 26, 1898, (No. 602,924), a lathe in which he placed the cone of gears in the apron instead of in or near the head, connecting it with the lead screw by a clutch, which is closed by the lever operating the lead screw nut. Two cones of gears, on which the changes are made by a sliding key, are placed at the end of the bed. The serious objection to the placing of the gears in the apron seems to be an undue loading down of the apron and carriage, as well as very much complicating these parts without a corresponding increase of efficiency. The inventor's reason for the innovation is the elimination of torsional strain in the lead screw, which is much more economically attained by enlarging the lead screw to a proper diameter. In the drawings, Fig. 1, is a side elevation; Fig. 2, is an end elevation; Fig. 3, is a longitudinal section through the cone of gears in the apron, and Fig. 4, shows a cross section of the shifting lever. Power is transmitted in the usual manner from the head spindle, through the gears *a*, *b*, *c*, *d* and *e*, to the first cone of gears *f*, all of which engage the opposite gear of the cone of gears *g*, on the shaft *h*. Either of the gears of the cone *g*, may be brought into action by a sliding key operated by the knob *i*, thus making five changes of speed. Upon a sleeve mounted on the lead screw *E*, are the ten gears *j*, *j*, *j*, etc., forming the cone of gears. Upon the hub of the largest gear is formed a clutch member adapted to be engaged by a similar clutch member formed upon the sliding clutch *k*, upon which are also formed rack teeth *l*, engaging similar teeth on two bell-crank levers *m*, *m*, which are operated by pins fixed on the two parts of the lead screw nut *N*. The shifting lever *P*, carrying the connecting gear *Q*, is arranged and operates in the usual manner, as shown in Figs. 1 and 4. It is not known who the brilliant scholar was who wrote this specification, or whether he has been relegated to "innocuous desuetude" since the seven printed pages with their thirty claims were printed, but in several respects this document is a literary marvel, in five pages of which the personal pronoun, I, occurs about thirty times.



Ernest J. Flather. No. 595,562, December 14, 1897.



Benj. A. Wheeler. No. 602,924, April 26, 1898.

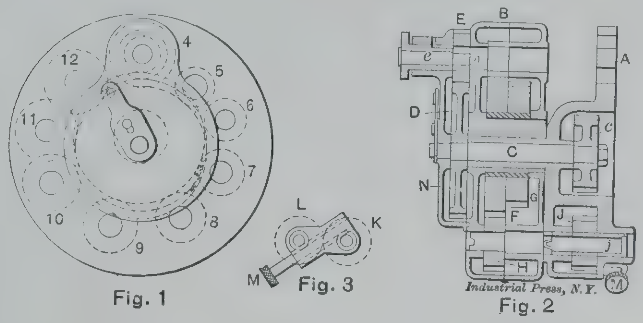


William L. Shellenback. No. 638,359, December 5, 1899.

On December 5, 1899, William L. Shellenback, of Philadelphia, Penn., obtained Patent No. 638,359, in which he followed Edward Flather, 1895, and Burdick, 1895, in the arrangement of a disk of gears in which he simplified the device of Flather, but hardly equalled the ingenuity or efficiency of that of Burdick. In the drawings, Fig. 1 is a face view of the device, and Fig. 2 is a vertical section on the center line. A circular case *A*, contains the gearing, and is journaled on a main shaft, *B*, which is fixed to and derives its power from the head spindle through gear *b*. The main shaft has fixed to it driving gear *C*, engaging with the pinion *D*, fixed to a short spindle *d*, journaled in the rotating arm *P*. Arranged around the gear case *A*, is a series of gears, all engaging each other, as shown by the heavy dotted circles in Fig. 1, and provided with clutch members to be engaged as required, by the spindle *d*, of the rotating arm *P*, to transmit motion to the train, and by a similar clutch at *E*, to convey the power at varying speeds to the lead screw. By withdrawing the clutch *d* from engagement the rotating arm *P* may be carried around to a proper position to bring into action any gear of the series. While the changes are not great in number, they might easily be doubled or multiplied by four, by the usual arrangement of intermeshing cones of gears, or by sliding gears.

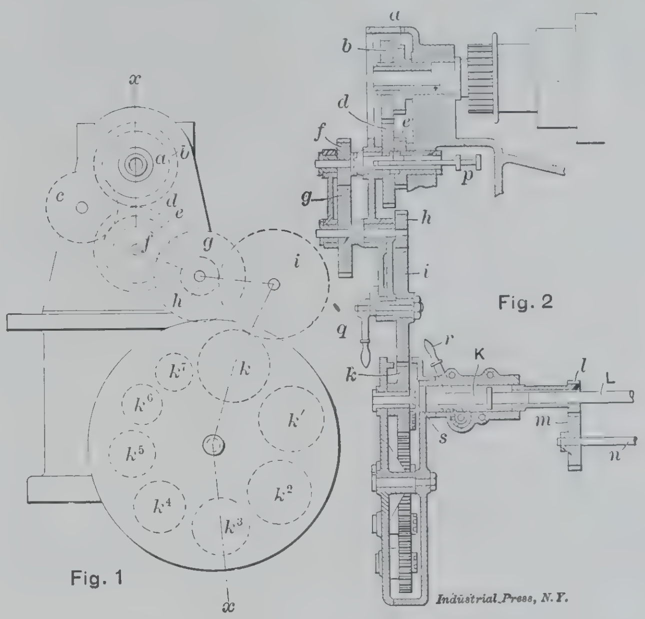
William L. Shellenback, in Patent No. 667,406, dated February 5, 1901, revised his device shown in Patent No. 638,359, making it a double disk of gears, and mounting them eccentrically after the manner shown by Burdick in 1895. In this device he improved quite considerably on his former effort in 1899, evidently profiting by the rapidly advancing state of the art, and the necessity for making a greater number of changes. In the drawing, Fig. 1 is a face view of the device; Fig. 2, is a vertical section, and Fig. 3, is an elevation of the reversing device. The device is supported upon an attaching plate *A*, which has formed upon it a sleeve, upon which the gear case *B*, is journaled. Through this case passes the main shaft *C*, having fixed upon it the gear *c*, which receives the driving power from the lathe. Upon the opposite end of the shaft *C*, is fixed the main driving gear *D*, engaging the gear *E*, in the rotating housing. Upon the hub of the gear case *B*, are journaled the gears *F*, and *G*, fixed to each other, the gear *F*, being adapted to mesh with the gears 4, 6, 7, 8, 9, and 11, of the front portion of the gear case, and the gear *G*, to mesh with the gears 5, 10, and 12, located in the rear portion of the gear casing, (not shown in Fig. 2). The gear casing *B*, being journaled eccentrically on the supporting sleeve, it follows that only the gears brought into engagement by arriving at the proper side of this eccentric movement will be in action. Each of the series of gears, 4, 5, 6, 7, 8, 9, 10, 11, and 12, are fixed upon shafts having clutch members formed upon both ends so as to engage with the clutch member on the end of the spindle *e*, of the secondary case *N*, on the one side, and with the clutch member on the spindle *j*, of the gear *J*, on the other. By thus providing for the revolution of the main gear case *B*, and the secondary gear case *N*, a large number of changes are possible. The device shown in Fig. 3, has two pinions cut on the shaft of the knurled head *M*, by which the spindles of the gears

L, and *K*, may be moved, one into engagement and the other out, and *vice versa*, for the purpose of reversing the direction of the feed mechanism.

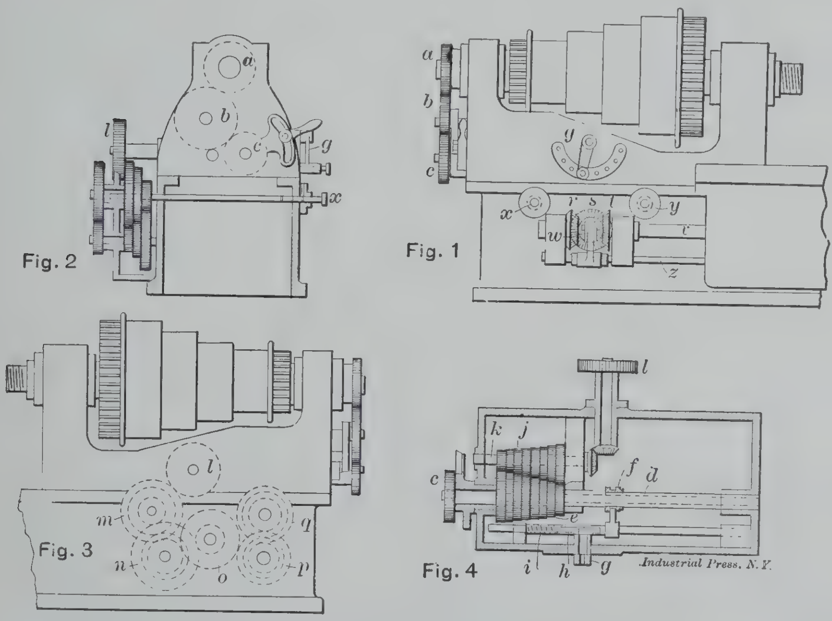


William L. Shellenback. No. 667,406, February 5, 1901.

In Patent No. 679,568, granted July 30, 1901, to Edward A. Muller, of Springfield, Ohio, we find a combination of clutches, sliding splines, swinging stud plates, rack and pinion, gears mounted on disks, gears journaled in casings, gears on the head spindle, gears on primary shafts, gears on secondary shafts, gears on supplementary shafts, in delightful profusion to the student, but we fear in confusion to the every-day mechanic. In the drawing, Fig. 1 is a face view of the invention, and Fig. 2, is a sectional development of the train of gearing on the dotted line *x*, *x*, Fig. 1. The direction of the transmission of power is readily seen in Fig. 1, from the gear *a*, through *c*, to *e*, or directly from *b*, to *d*, thence by the gear *f* to *g* and from *h* to *i* from which to any one of the series of eight gears marked *k*, k^1, k^2, etc., to the shaft *K*, and the lead screw *L*. From the lead screw the gears *l*, and *m*, drive the feed rod *n*. The gears *d*, and *e*, may either be brought into action by the rod *p*, operating the sliding key as shown in Fig. 2. The gears *f*, and *g*, are arranged with clutches as shown in Fig. 2, so that they and the connecting case in which they are journaled may be removed and another case of a different ratio of gears substituted, whereby the changes made possible by the gears *a*, *b*, *c*, *d*, and *e*, may be further increased. The gear *i*, is journaled upon a swinging arm clamped in position by the lever *q*, as may be necessary to bring the gear into engagement with any one of the series *k*, k^1, k^2, k^3, etc., as the gear case containing them is rotated. When the proper gear of the series is in position the shaft *K*, is brought into position to engage the clutch *s*, by means of the lever *r*. The shaft *K*, is splined to the sleeve on which the gear *l*, is formed. The lead screw *L*, is also splined to it and is thus driven with it.



Edward A. Muller. No. 679,568, July 30, 1901.



Herman R. Isler. No. 684,432, October 15, 1901.

Herman R. Isler, in his Patent No. 684,432, dated October 15, 1901, seems to have had great faith in the efficiency of the much used cone of gears, and may have thought that if they were good things, the more he had the better, for he not only places two cones of gears in the bed, but mounts four more cones of gears, together with various connecting gears at the back of the head on shafts journaled in the bed. These are all operated by sliding keys, while racks, segments, and bevel gears are introduced with a lavish hand. The arrangement doubtless proved rather expensive as well as unnecessarily complicated. It would not probably be too much to say that he was well acquainted with Norton's reversing bevel gears. In the drawing, Fig. 1 is a front elevation; Fig. 2 is an end elevation, showing the bed and a portion of the rear gear casings in section; Fig. 3, is a rear elevation, and Fig. 4, is a horizontal section through a portion of the head. The power is taken in the usual manner through the gears *a*, *b*, *c*, to the shaft *d*, upon which one cone of gears *e*, is journaled. Any one of these gears is brought into action by a sliding key operated by the clutch sleeve *f*, controlled by the lever *g*, through the medium of the segment *h*, and rack *i*. The gears of the cone *e*, engage those of the cone of gears *j*, fixed upon the shaft *k*, from which miter gears connect to the gear *l*, and thence to the series of gears at the back shown in Figs. 2 and 3. The motion here passes through the gears *m*, *n*, *o*, *p* and *q*, and thence to the reversing bevel gears *r*, *s*, *t*, to the lead screw *V*. The cone of gears *n*, and *p*, are fixed to their shafts, while those of the cone of gears *m*, and *q*, are controlled by sliding keys operated by the knobs *x*, and *y*. The reversing clutch *w* is operated by a quick-threaded worm on the reversing rod *z*, whose rotation is controlled at the apron.

* * *

What appears to be a simple scheme for greatly increasing the magnifying power of the microscope, has been developed by two professors in Jena University, according to a recent report from Consul Monaghan at Chemnitz, Germany. Some years ago the limit of microscopic perception was declared by the great physicist, Helmholz, to be 0.000004 inch, but it is estimated that the recent discovery will extend it to particles of matter so small as 0.0000002 to 0.0000003 inch. The principle depends upon strongly illuminating the particles to be observed, and excluding all rays of light from the objective save those that are reflected from the object observed.

* * *

A French experimenter has made a discovery that should be of value in blueprinting by electric light. He has found that an arc lamp using carbons having a core of carbide of iron, will make blueprints and black drawings on white ground, or heliographic paper, three times more quickly than when ordinary carbons are used.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JULY, 1903.

NET CIRCULATION FOR JUNE, 1903,—27,165 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

One of the great drawbacks to the more general use of steel castings, as almost everyone knows, is getting them to come sound and reasonably true to pattern. It is somewhat discouraging to send a simple pattern to a steel foundry and receive in return castings that bear only a remote resemblance to the pattern sent, or are so full of blowholes as to be worthless. It is no exaggeration to say that this has been the experience of many manufacturers who would gladly be large users of steel castings if these could be obtained promptly and true to pattern. A more favorable aspect of the steel casting business was revealed to us on the occasion of a recent visit to the shops of the National Transit Co. at Oil City, Pa. This concern, which makes pumping machinery, gas engines, and other oil field machinery required by the Standard Oil Co., uses steel castings very largely for connecting-rods, crankshafts, and other machine parts requiring a strong, tough metal. These castings are made in their own foundry and they are without exception the finest specimens of the art we have seen. Mr. Klein, the former superintendent, now dead, invented a steel converter which is used and which is held to be largely responsible for the uniform results obtained. The foundry practice, however, reveals a grasp of the business on the part of the foundry foreman that shows he is master of his business. Almost everything is cast on end that can be handled in that way, gating from the bottom, of course, and providing risers of generous proportions. We were shown castings for a poppet valve of quite complicated shape, that is regularly made, which would test the skill of most molders to produce in cast iron. They were apparently perfect in every respect. In the production of three-throw crankshafts and other parts that are equally difficult to make, there seems to be no trouble in obtaining steel castings by this method that are true to the pattern and are satisfactory in every respect.

* * *

CANNOT BE PREVENTED.

One of the most peculiar advertisements, (if we may so describe it) we have ever read, was inserted in the June issue of *Power* by an engineer of world-wide reputation—the father of the modern high-speed stationary steam engine. It is in effect a protest against the steam turbine, and is addressed to the builders of stationary and marine steam engines and would not call for special attention were it not that it so vividly illustrates a certain temper of the human mind that is periodically manifested whenever great improvements are first launched. The advertisement, in part, reads as follows:

> Gentlemen: As you are well aware, your business is now confronted with the competition of the steam turbine. It is the prophecy of its promotors that the reciprocating steam engine will soon become a thing of the past. The general trend of engineering opinion seems to be in that direction.
>
> Pumping and air compressing engines, and rolling mill engines, will not be affected by this competition. But the great classes of engines employed in most other industries, and for driving dynamos and marine engines are, *in their present forms,* pretty certain to be gradually superseded. On this point there seems to be little room for difference of opinion. The advantages of the turbine are very great.
>
> Are there any means by which this threatened result can be prevented?
>
> I am satisfied that this will be done by the more complete development of the high speed system—the combination of rapid piston velocity with short strokes. In this way a reciprocating engine will be obtained that will be preferred to the turbine. * * * *
>
> As is sufficiently well known, I have devoted my life largely to the study and practical application of the principles of high speed engineering. For a number of years recently I have been engaged in maturing, both in its general features and its details, a high speed system which seems to me well adapted to present requirements. * * * *
>
> Steam engine builders, stationary and marine, are invited to communicate with me, when I will arrange to meet parties who shall propose to unite in this enterprise and lay its details before them.
>
> Montclair, N. J. Charles T. Porter.

Superficially, this advertisement appears to be for the purpose of promoting a new invention, but we suspect that at heart the writer, who is a true engineer, with love for his profession, feels much deeper than this. The keynote of what he says seems to be: "Are there any means by which this threatened result can be prevented?" No matter if the steam turbine is better than the reciprocating engine, no matter if the world wants it because it is simpler, we, the men who have given our lives and best thoughts to the development of the steam engine, cannot bear to see it superseded. Vested interests are not of so much account here as sentiment. Naturally so, and this trait of human nature must be taken into account when dealing with men who have been prominently connected with the development of any great industry or enterprise. The father of the high-speed steam engine can perhaps console himself with the thought that if the steam turbine does supersede the reciprocating engine, it in turn will undoubtedly be shifted from the stage of action by some process for the direct conversion of heat into electrical energy. This is now accomplished in the laboratory and it is probable that it will eventually be done on a commercial scale.

It is perhaps impossible for any of us to view, without a tinge of sadness, the displacement of the old for the new, but improvements and progress are in effect synonymous with change. No motor, tool or appliance in the world of mechanics can crystallize into a permanent form; types must change or disappear as the conditions affecting them require. The lesson for the young man, and for all men to learn if they can, is that nothing is permanent and that if they would keep abreast with progress their minds must always be receptive to new ideas.

* * *

There is on record a considerable number of air compressor explosions, more or less disastrous, which are definitely known to have been caused by the "spontaneous" firing of confined explosive gases, of which the lubricating oil fed to the compressor cylinder, formed the hydrocarbon constituent. The heat generated by compression is sufficient to fire an explosive mixture of air and hydrocarbon gas, under favorable conditions, as can be demonstrated by experiment. The use of a lubricant for air compressor cylinders having innocuous qualities would seem desirable, especially where single-stage compressors are employed for pressures of 90 to 100 pounds or higher. Even if there is no danger of explosion there is always the trouble from carbon being deposited on the outlet valves and passages. The *American Manufacturer* of a recent date describes a lubricator for feeding soapsuds to an air compressor which is successfully used in the power plant of the Terminal Railroad Association at St. Louis, Mo. Soapsuds have been used there in an Ingersoll-Sergeant air compressor for the past four years. The lubrication has been satisfactory and the walls of the cylinder are said to be in perfect condition. All this being true, we have the very desirable elements of cheapness and superiority combined in a simple air cylinder lubricating compound available wherever people are addicted to the "soap-and-water habit."

HIGH-SPEED PLANERS AGAIN.

In regard to high-speed planer work, which was discussed in the June issue, a belated report comes from the Mark Flather Planer Co., who say that on small planers 30-inch by 30-inch and under, a cutting speed of from 35 to 40 feet per minute is being employed with success, and that they are running planers of this size at about these speeds. They are operating a 42-inch by 42-inch planer, widened out to 50 inches, which has an 18-foot table and four heads, at a cutting speed of 28 feet per minute. But while this increase of cutting speed greatly increases the output, it is frequently necessary to make repairs. It does not appear possible to make certain parts of the planer, as now designed, strong and rigid enough to stand the shock and stress of such high speeds. Again the experience of this firm with the new high-speed steels, yields a varied degree of satisfaction. One tool may last for a long time with one grinding, and with such a tool the work progresses rapidly. Another tool, made possibly at the same time by the same smith and hardened in apparently the same way, will not stand up at all. The company are furnishing some 48-inch by 48-inch planers to the Locomotive & Machine Co., of Montreal, which are guaranteed to plane at 35 feet per minute. It is expected that these machines will show a great increase in consumption of power as the makers have found that the increase of power required is by no means pro rata with the increase of cutting speed, but rather in some geometric ratio. In conclusion they do not recommend high planer speeds, believing it is better to go a little more slowly and lengthen the life of the tools and the machine. A cutting speed of 30 feet per minute is recommended for planers 30 inches by 30 inches and under, and 25 to 27 feet for larger sizes up to and including 48-inch by 48-inch. Beyond these sizes the speed should be reduced from 22 to 23 feet per minute.

The highest high-speed record that has come to us, with the exception of a report from one G. A. Gray planer, which we understand is running at the rate of 66 feet cutting speed, has been sent by the American Tool Works Company, Cincinnati, who have paid a great deal of attention to the question of fast cutting speeds for planers. A test was recently made at their works upon one of their standard 24-inch machines, using in connection a well-known brand of high speed tool steel. The platen was planed off at a speed of 60 feet a minute, the depth of cut being ⅜ inch, and the feed 1-16 inch. The platen was then finished at the same speed without chatter, the cut being smooth, clean and even throughout. The same speed and cut was then repeated on a piece of work clamped to the planer table. Since these tests work has been done regularly on 30-inch planers at 60 feet a minute with this high-speed steel.

* * *

THE NATIONAL MACHINE TOOL BUILDERS' MEETING.

The semi-annual meeting of the National Machine Tool Builders' Association held on June 9, 10 and 11 at Worcester, Mass., was more largely attended than any of the previous meetings. Interest in the objects for which the association was formed has steadily increased, and it may be now regarded as a permanent and successful adjunct of the trade. The only business of importance transacted was an agreement to increase the price of planers 5 per cent., but a number of minor points of general interest, such as the regulation of prices on machine tool parts were discussed, and steps taken to secure uniformity. Mr. W. A. Viall, of the Brown & Sharpe Mfg. Co., read a paper on the apprenticeship system in force at their establishment, which contained a number of valuable points. The visiting members of the Association and guests were entertained by the Worcester members at Lake Quinsigamond, and by the Norton Emery Wheel Co. at their works, and every one present had a most enjoyable time.

The following firms are members of the Association: Flather & Co., Mark Flather Planer Co., Nashua, N. H.; Jones & Lamson Machine Co., Springfield, Vt.; Baush Machine Tool Co., Springfield, Mass.; H. G. Barr, Blaisdell & Co., Draper Machine Tool Co., Prentice Bros. Co., F. E. Reed Co., Whitcomb Mfg. Co., Woodward & Powell Planer Co., Worcester, Mass.; Hendey Machine Co., Torrington, Conn.; Detrick & Harvey Machine Co., Baltimore, Md.; Binsse Mche. Co., Gould & Eberhardt, Newark, N. J.; W. P. Davis Machine Co., Rochester, N. Y.; B. F. Barnes Co., Rockford, Ill.; Hoefer Mfg. Co., Freeport, Ill.; Aurora Tool Works, Aurora, Ind.; Sibley & Ware, South Bend, Ind.; Bremer Machine & Tool Co., Kalamazoo, Mich.; American Tool Works Co., Bradford Machine Tool Co., Bickford Drill & Tool Co., Cincinnati Machine Tool Co., Cincinnati Milling Machine Co., Cincinnati Planer Co., Cincinnati Shaper Co., Dietz Machine Tool Co., Fosdick Machine Tool Co., Greaves, Klusman & Co., Hisey-Wolf Machine Co., Lodge & Shipley Machine Tool Co., R. K. LeBlond Machine Tool Co., Rahn, Mayer, Carpenter Co., Schumacher & Boye, Cincinnati, Ohio; Hamilton Machine Tool Co., Hamilton, Ohio; Fairbanks Machine Tool Co., Springfield Machine Tool Co., Springfield, Ohio.

* * *

NOTES AND COMMENT.

The question of starting a course in "insurance engineering" at the Massachusetts Institute of Technology has been agitated for some time by the Factory Mutual Insurance companies of Boston and probably this result will eventually be consummated. The Armour Institute of Technology, Chicago, however, has gotten in ahead and has already started such a department for instruction in fire protection. The course is to be known as "Fire Protection Engineering," and will lead to the degree of Bachelor of Science. It will be under the direction of Prof. Fitzhugh Taylor, formerly engineer of the Underwriters' Laboratories. A special feature of the course will be a series of lectures by prominent insurance officials, architects and contractors.

"*The Aeronautical World*," devoted to the interests of sky navigation, is one of the latest additions to the journalistic field. The advertising columns are the most interesting part of the paper. From them we learn that the Aeromobile (60 miles an hour guaranteed) for navigating the air, water or on land, is a new type of conveyance for which a limited number of orders will be booked at $600 each. The advertisement says, "Don't waste time asking questions, but if you mean business and command the cash send your order." Another inventor who has "proved" the practicability of a flying machine wants to raise the capital. Two people wish to sell gasoline motors which are "just the thing for air ships." Another man, who evidently tells the truth, advertises, "Clever performer with good hot air attachment is open to book engagements."

A contemporary gives a somewhat extended description of a variable-speed engine governor of the fly-ball type, in which the speed of the engine is changed by varying the relative position of two beveled friction disks which take the place of the familiar bevel gears. On general principles we believe a device of this nature should be discouraged. There have been entirely too many wrecks caused by runaway engines in which loose or broken belts have played the leading part. To introduce a friction device much more likely to slip and get out of order than the belt, is little less than criminal, and should never be allowed. An engine governor should always be positively driven either by chain or shaft connection. We are aware that blowing engines have been controlled by a variable-speed device of a similar nature to the one under discussion, but that does not alter the conditions affecting ordinary commercial engines. A blowing engine is always under close surveillance, and even then the device alluded to has often given serious trouble.

In one of his papers presented at the Saratoga convention, A. H. Eldredge tells of two engines which he equipped with positive governor drives, with marked improvement in their running qualities. The belt drives had not only given trouble through slipping and consequent irregular running of the engines, but at times had been in such bad shape as to become positively dangerous. The positive drives changed all this. Mr. Eldredge did what European engineers have practiced for many years and other American engineers may well follow their example.

SIXTY-FOOT BORING MILL

RECENTLY BUILT AND ERECTED AT THE GENERAL ELECTRIC CO.'S WORKS.

The boring mill, of which a description follows, was the subject of a paper by Mr. John Riddell, Schenectady, N. Y., before the Saratoga convention of the American Society of Mechanical Engineers. This machine was designed for machining field rings of dynamo-electric machines, flywheels and other large work at the General Electric Co.'s works, Schenectady, and is of such immense proportions and weight of material that it was necessary to build it at the factory where it was to be used. The total weight of the boring mill complete is 885,600 pounds and it is capable of taking work 60 feet in diameter. Up to the present time the largest boring mills in the country, so far as we know, have been two 28-foot mills built by William Sellers & Co. for the Westinghouse shops, Pittsburg, and a 30-foot mill at the Union Iron Works, San Francisco, Cal. The General Electric machine, therefore, will take work of twice the diameter of these and is much the largest and heaviest boring and turning mill ever constructed in this country and probably in any other country. It is hardly fair to make direct comparisons between this machine and the others, for it is a special machine, designed for special work, while the Sellers mills, at least, are tools of the regular type, relatively heavier, and adapted for work of relatively greater height above the table without the introduction of what might be termed "portable features." The cross-rail and saddles of the General Electric machine together weigh 155,000 pounds and of the Sellers mills 111,000 pounds. The rail of the former is about 38 feet long, made in two parts, and supported at the center as shown in Figs. 1 and 2. When unusually large pieces are to be turned the housings are moved back onto the projecting parts of the floor plate. The General Electric machine has a boring bar with independent drive and feeds, which can be used either for boring or slotting, and which greatly increases the scope of the mill. The following is an abstract of Mr. Riddell's paper:

When the excavation was made for this foundation a bed of quicksand was struck at a depth of 8 feet, which rendered it necessary to have a steel tank, 9 feet in diameter by 12 feet 9½ inches in height, sunk to keep back the sand and water. It was found impossible to sink this tank by the regular method of digging, and the hydraulic process of sinking was resorted to. After the tank was in place, as much earth as possible was removed from the outside, gradually rounding the bottom up toward the outer edge of the foundation, the object being to keep the bottom of the foundation in as nearly a semi-spherical form as possible, so that in settling it would adjust itself in a solid mass. The bed of the mill is 20 feet in diameter and for convenience is made in three pieces, one pattern only being necessary. Each segment weighs 26,900 pounds, making a total of 80,700 pounds. The bed plate has two ways for the table to revolve upon, the center of outside way being 17 feet 6 inches in diameter and 10 inches

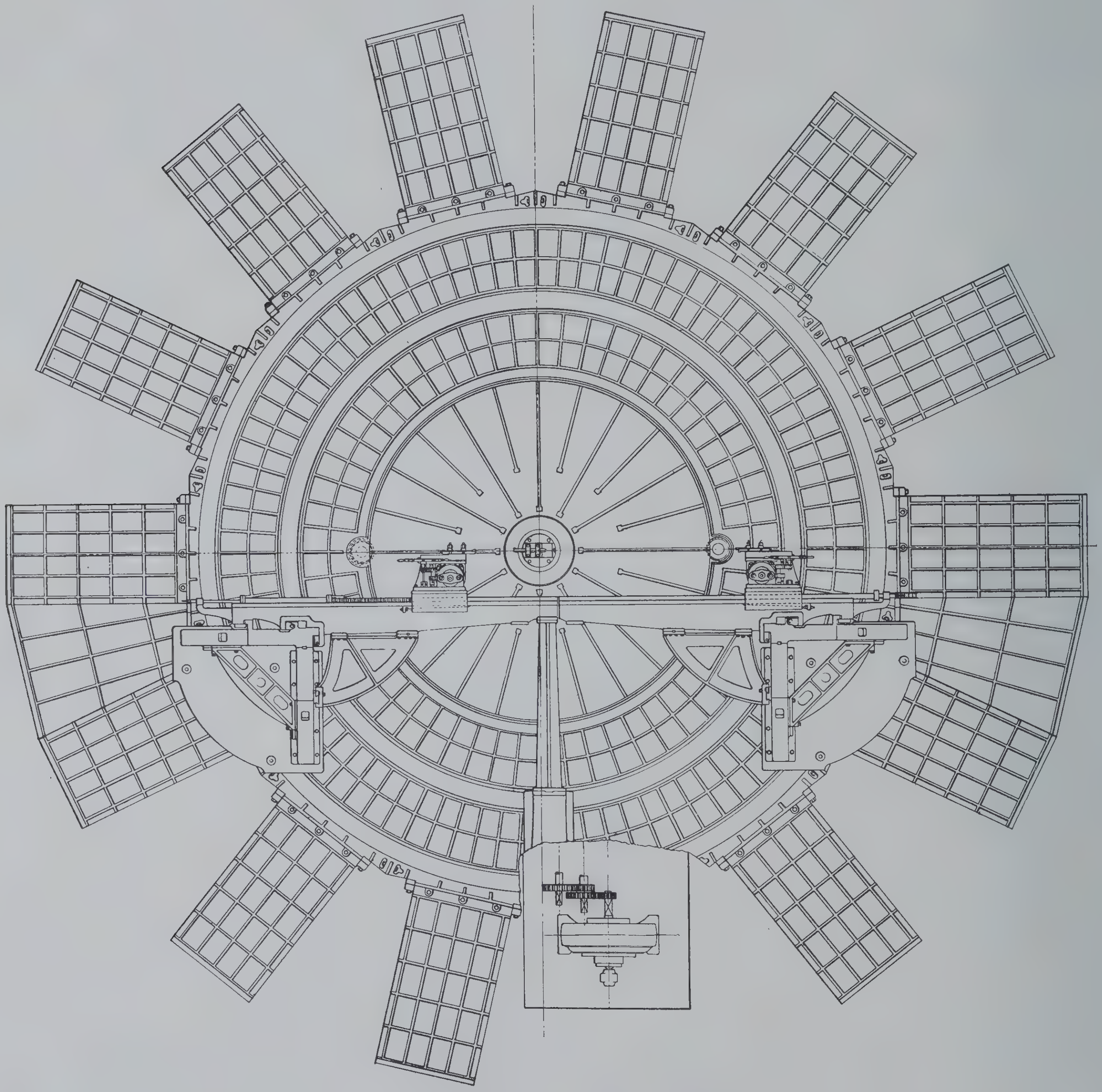
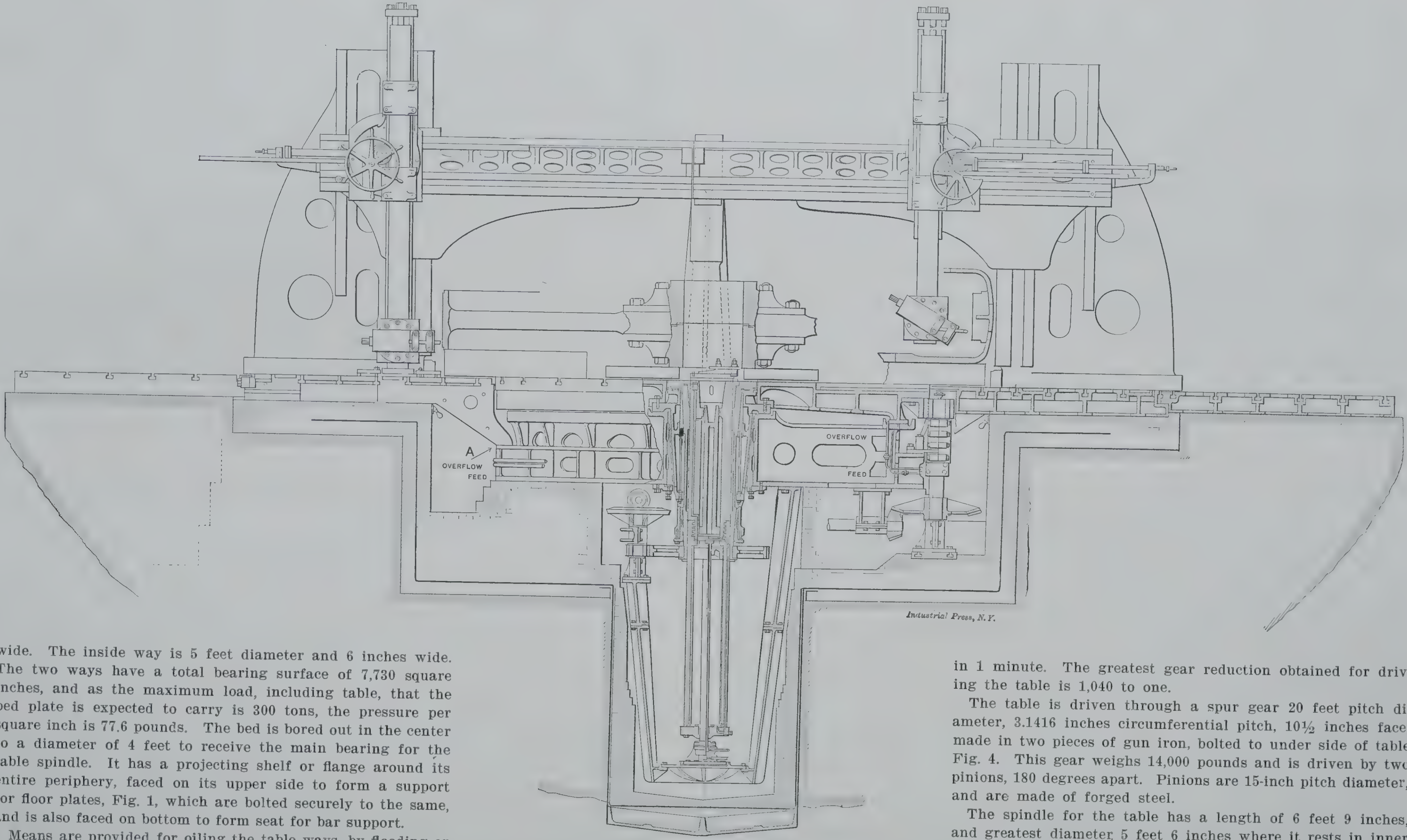


Fig. 1. Plan View of Sixty-foot Boring Mill.



Industrial Press, N.Y.

Fig. 2. Sectional Elevation through Boring Mill.

wide. The inside way is 5 feet diameter and 6 inches wide. The two ways have a total bearing surface of 7,730 square inches, and as the maximum load, including table, that the bed plate is expected to carry is 300 tons, the pressure per square inch is 77.6 pounds. The bed is bored out in the center to a diameter of 4 feet to receive the main bearing for the table spindle. It has a projecting shelf or flange around its entire periphery, faced on its upper side to form a support for floor plates, Fig. 1, which are bolted securely to the same, and is also faced on bottom to form seat for bar support.

Means are provided for oiling the table ways, by flooding or by pressure; the flanges at sides of ways form an oil well and are of sufficient height to allow a head of 2 inches of oil above surface of bearing at all times. (It may be of interest to know that 32 gallons of oil are required for this purpose.)

The table is 20 feet 4 inches in diameter, made in three sections, and weighs complete 78,900 pounds. It has a range in speeds from one revolution in 8 minutes to one revolution in 1 minute. The greatest gear reduction obtained for driving the table is 1,040 to one.

The table is driven through a spur gear 20 feet pitch diameter, 3.1416 inches circumferential pitch, 10½ inches face, made in two pieces of gun iron, bolted to under side of table Fig. 4. This gear weighs 14,000 pounds and is driven by two pinions, 180 degrees apart. Pinions are 15-inch pitch diameter, and are made of forged steel.

The spindle for the table has a length of 6 feet 9 inches, and greatest diameter 5 feet 6 inches where it rests in inner way of bed plate, and has a taper of ¾ inch per foot on main bearing, being 46 inches diameter at large end and 40 inches long; weight of same being 10,100 pounds. It is also bored out and splined at each end to receive bearings for the boring bar sleeve, and also adjustments for the same. Bearing for table spindle is 48 inches outside diameter, 40 inches long, has babbitted pockets on inside for spindle bearing, bored to a diameter of 46 inches at large end with ¾-inch taper per foot. This bearing weighs 3,700 pounds. Immediately outside of revolving table there are 14 floor plates, making a stationary table of 44 feet diameter, each plate weighing 19,000 pounds, making a total of 266,000 pounds. Outside of this table there extend 15 plates radially, 6 feet wide by 10 feet 6 inches long, making a complete outside diameter of 65 feet. Each of these plates weighs 13,000 pounds, making a total weight for the 15 of 195,000 pounds.

The stationary table has two tracks upon its surface, center of inside track being 30 feet diameter and center of outside track 40 feet diameter, both 12 inches wide. The object of these tracks is to form an outer bearing for support on which boring tool heads rest when boring out large flywheels or frames, or forming outer bearings for frames or flywheels when they are being revolved by the table and are being turned on their outside diameters. These tracks are covered by a moving platform, to protect them from chips or dirt, and upon which the operator may stand.

The mill is equipped with a boring bar supported from beneath the table and designed for boring out work varying from one foot to eight feet in diameter by 16 feet long and is made to revolve in either direction by means of suitable gearing and reversing clutches. The bar is to have a hydraulic feed, and is built up of two cylinders, the upper 12 inches diameter, with 4 feet 8 inches travel and the lower 18 inches, bushed with copper sleeve to 17½ inches diameter, and with a travel of 8 feet. The piston of lower cylinder is stationary and mounted securely upon a hollow piston rod, which contains an internal tube that passes up through the piston to upper end of cylinder. Oil for upper end passes through this tube and for lower end through outside or piston rod tube and by means of port in the same near its connection with the piston passes into cylinder; thus, by admitting oil to under side of piston, the bar or cylinder moves downward and admission to upper side gives motion upward.

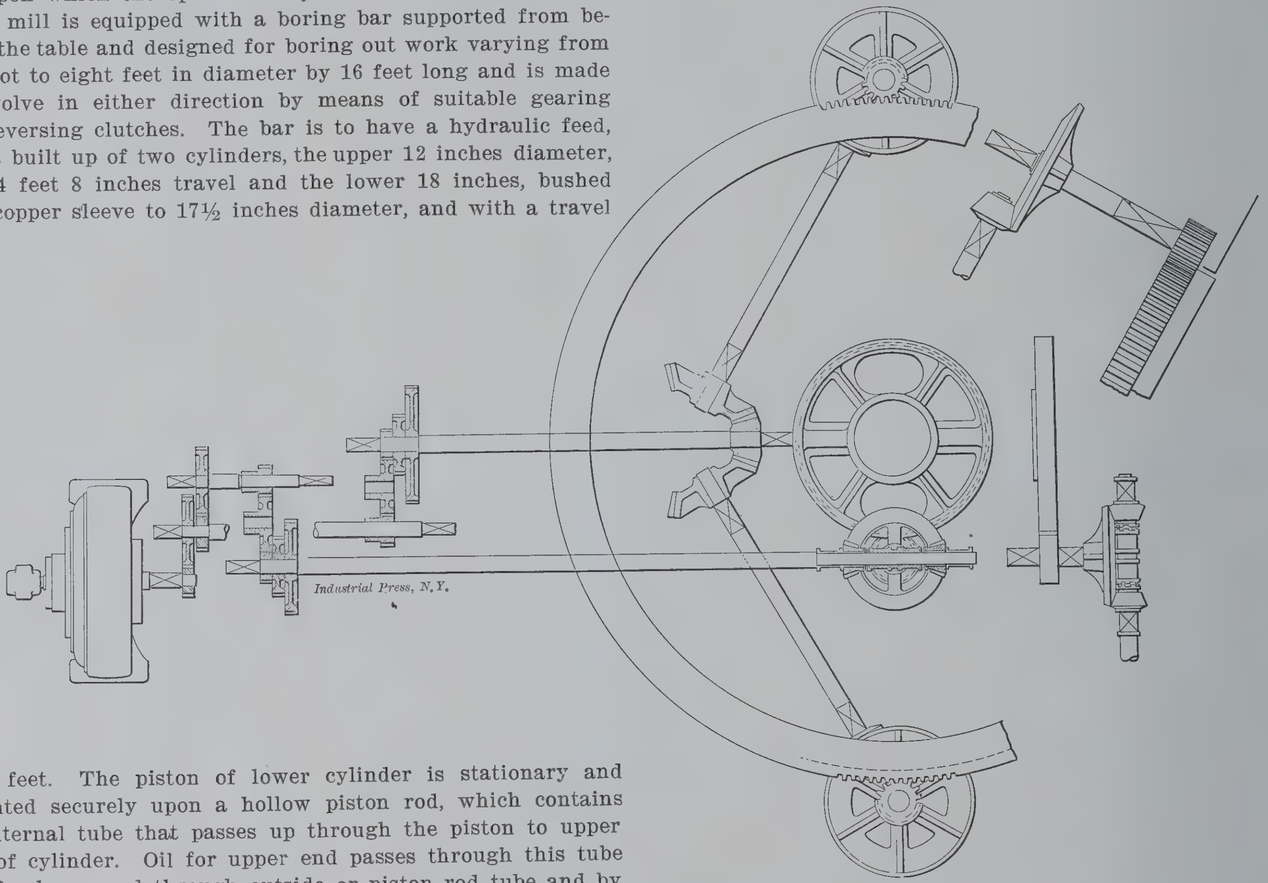

Industrial Press, N.Y.

Fig. 3. Plan of Drive for Boring Mill Table and for Boring Bar.

Should it be necessary to bore out a piece of work 24 inches or less in diameter, recourse is then had to the upper cylinder, where there is a double-acting piston, the rod of which is 8 inches diameter and forms the boring bar. Oil for operating this plunger is obtained as follows: A valve in bottom cylinder head is opened, the oil passes through valve up through pipe which is embedded in side of bar, up to and through inner head between upper and lower cylinders, thence to under side of top piston; the feed being controlled by the quantity of oil allowed to escape from upper side of piston. It will thus be seen that pressure is on both sides of both pistons at the same time, the pressure from pump being at the lower side of top piston and lower side of bottom piston, while the exhaust is on opposite side of pistons; this is to prevent any jumping effect of the bars in vertical direction when blowholes or other obstructions are encountered. By reversing the main operating valve, feed in opposite direction is obtained, the top of large bar and small plunger being made with taper sockets and key to carry boring heads. These boring heads are provided with suitable crossfeed slides to bore to diameter required. Thus when keyways are required, the same may be done by removing the boring tools and substituting slotting tools, and then by manipulating the main operating valve the bar may be given the cutting speed required and also have a quick return.

The bar support is made up of cast-iron segments machined and bolted together and suspended from the under side of the bed plate. A photograph of this is reproduced in Fig. 8.

The housings are constructed entirely different from the standard type of vertical boring mill. There are two large portable uprights 15 feet high, having one part of upright standing in same line as the cross-rail and the other standing at right angles thereto, both forming part of common base 9 feet square and tied together on the inside near the top by a very strong brace. The arm or cross-rail, Fig. 2, which has a vertical adjustment on standards, has bearings and gibs between rail and housings of ample width and length to secure alignment of the same. There is also a large bracket at the back which slides upon back column of standard and a clamping device at end of rail, which passes across the face of housing, both of which when secured serve to prevent springing of the rail during operation. Additional support is given to rails where they join at the center, by means of a stationary stand and bracket extending out to and against the rail, as shown in plan of mill, these rails being of sufficient length to enable a minimum diameter of 12 inches and a maximum diameter of 28 feet to be bored and turned without moving the housings.

The design of cross-rail is peculiar in construction in having the lower face project 3½ inches beyond the upper part; this lower is 12 inches wide vertically and forms the main horizontal guide for saddle, one advantage being a double bearing to sustain the weight. The principal object is, however, greater accuracy and less liability for the saddle to oscillate, owing to the proportions of length to width of bearings, which is 12 x 42 inches, the usual proportions of large boring mill saddles being about square. The great width of rail to counteract the tool action is still retained.

Movement or feed of saddles along the rail is made by means of hydraulic mechanism, the piston and rod being

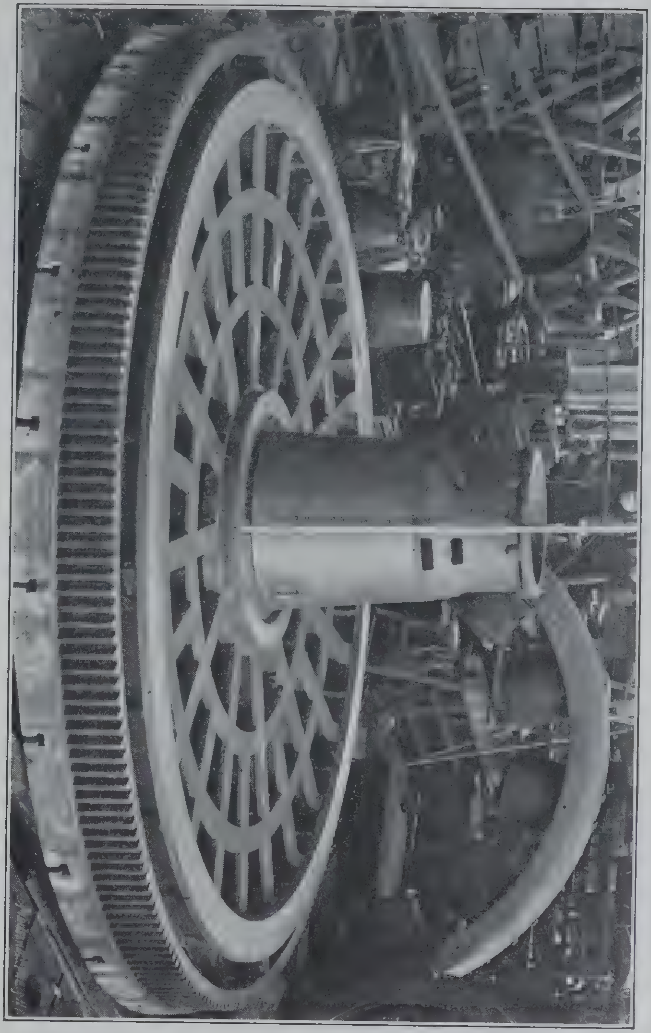


Fig. 4. Faceplate and Main Spindle.

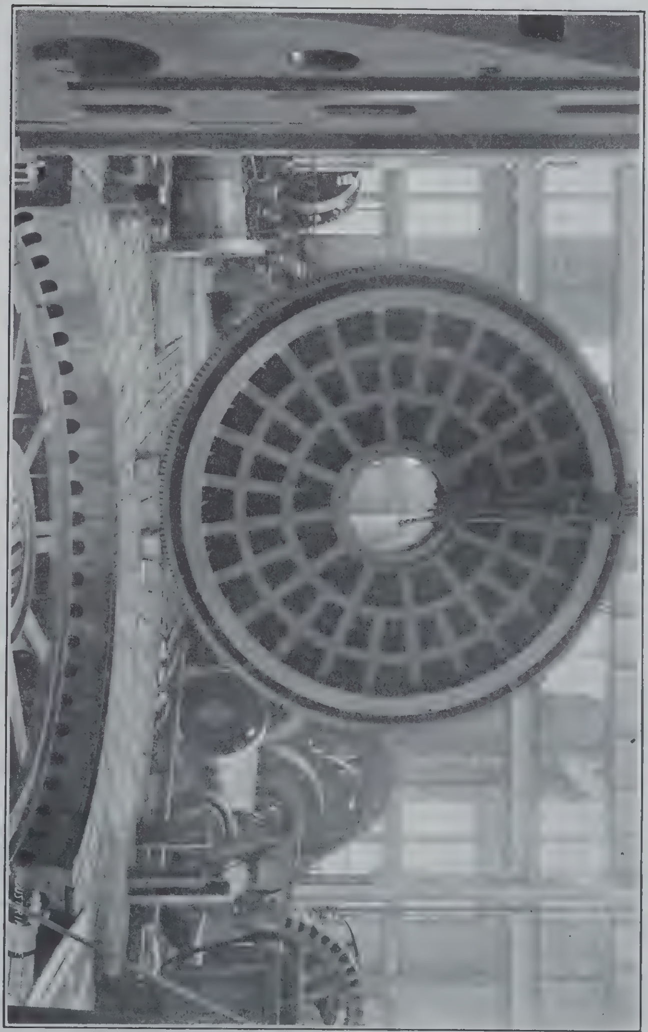


Fig. 5. Faceplate and Section of Bed.

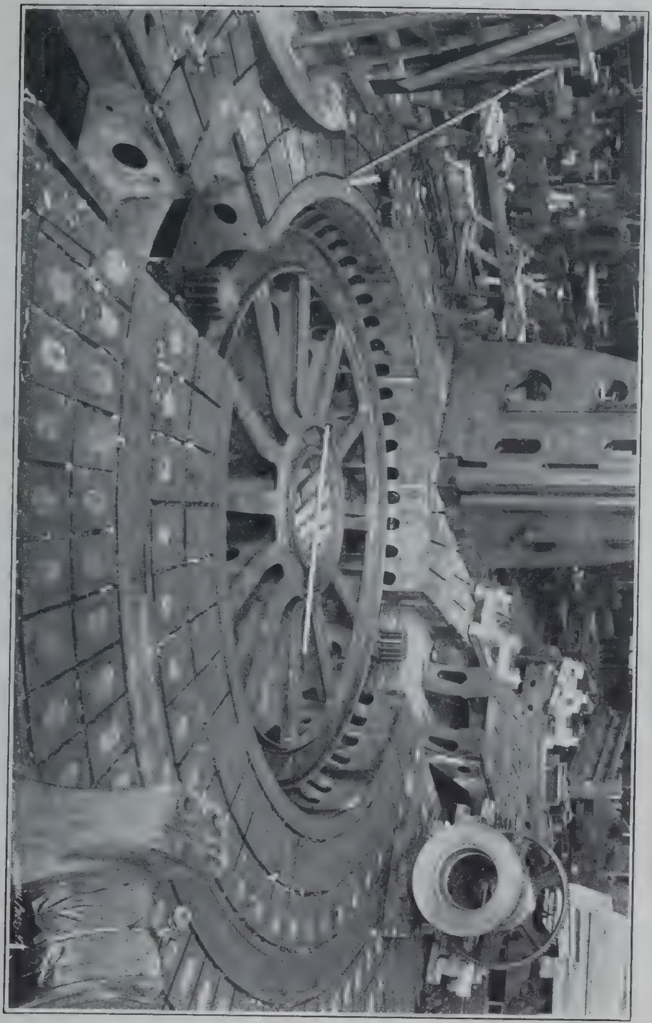


Fig. 6. Showing Bed, Bearings for Table, and Driving Pinions.

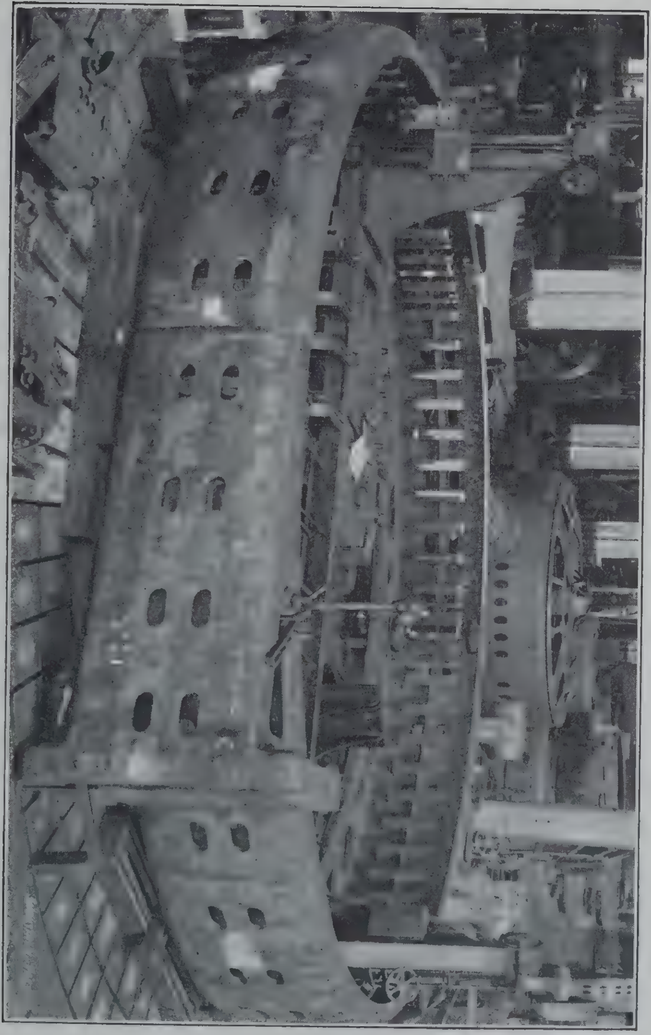


Fig. 7. Boring Mill at Work on Field Ring 34 feet in Diameter.

stationary and attached to bracket on outer end of rail. The cylinder is allowed to float, carrying on inner end a pair of gears proportioned two to one, which engages in two racks, the upper or stationary rack meshing with small gear, and the lower racks attached to saddle and meshing with large gear; this arrangement gives a motion of head equal to three times that of cylinder, pressure being admitted and discharged in the same manner as described for main boring bar.

The boring bars in tool heads—12 inches diameter by 15 feet long—are held in bearings on swivel plate, as on standard type of mill. This bar is bored out and fitted with a double-acting piston and hollow piston rod and cross head to which are attached two racks which serve as keys to prevent turning of bar and also for raising or lowering of bar or tool heads. The bar can be held in position as in standard mills, or can be lowered and clamped to floor when turning a piece of work. (See vertical section of boring mill, left-hand bar.)

The tool head is also provided with suitable device for raising or lowering bar by hand.

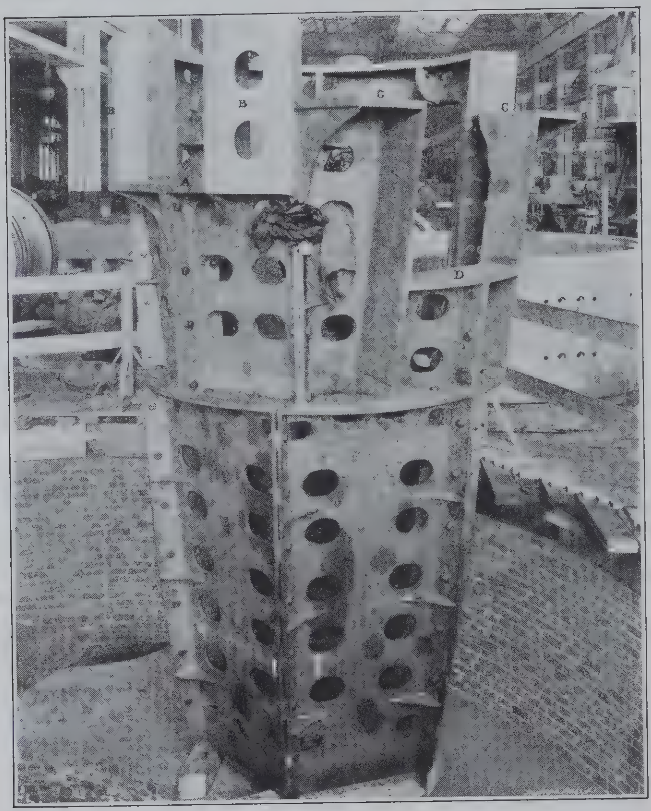


Fig. 8. Cast-Iron Support for the Boring Bar and Mechanism.

The tool head on bar consists of a cross-slide and swivel attachment, capable of being revolved around the bar by means of worm and wheel, and moved vertically along the bar by means of the two racks above mentioned.

The housings are supported by the stationary table and floor plates extending from the table to a diameter of 65 feet, being free to travel from a position close to table to outside diameter of plates, in which position they are capable of boring or turning work of a maximum diameter of 60 feet. Housing-rails, etc., weigh 155,580 pounds.

The power for driving this mill is obtained from a 50 horse power variable speed motor. This motor has a range of speeds of from 128 to 512 revolutions per minute inclusive, power being transmitted from pinion on armature shaft through train of gears to main driving shaft; Fig. 3, upon main driving shaft is a bevel pinion which meshes into two bevel gears on two shafts placed diagonally. Upon other end of this are two bevel pinions meshing in two large bevel gears, mounted upon vertical shafts, upon which are the two pinions for driving table gear. Motor is controlled by means of a portable controller, which can be carried to any point about the mill convenient for the operator. Fig. 7 shows the machine applied to boring a field ring 34 feet in diameter.

Net total weight of boring mill complete is 885,620 pounds.

* * *

PISTONS AND PACKING RINGS.—6.

J. H. DUNBAR.

This installment will be devoted to the description and discussion of balanced packing rings; and to explain what they are, and who was probably the first to note their importance, I make the following quotation from Mr. H. D. Dunbar's patent of 1865:

"It also consists in so forming the central and packing rings that the outward pressure of the steam within the piston-head may be limited and regulated so as to reduce to the minimum the amount of friction between the packing and interior surface of the cylinder, consistent with a steam-tight joint."

Mr. Dunbar's packing was described in the first article of this series, which appeared in MACHINERY for July, 1902.

The best evidence I know of that cylinder wear is, to some extent at least, proportional to the pressure on the piston is that shown by an air-pump cylinder, such as are used on locomotives. When these cylinders get worn about a thirty-second larger at the ends than in the middle, they are rebored. I measured up a badly worn cylinder a few years ago, and then magnified the wear fifty times, and the diagram Fig. 1 is the result. The lines are approximately isothermal, showing that when air is being pumped, cylinder wear is about proportional to the pressure on the piston. For general service, narrow rings, and few of them, lessen cylinder wear, but this is offset by the increased pressure of the rings against the cylinder walls and the difficulty in applying oil. A balanced packing ring is needed. I note a few.

Downie's packing for marine engines is of the type under discussion, and was shown in MACHINERY, January, 1903. It consists of a pair of snap rings, wedge shape in cross section, in a single groove which clamps the rings as they expand and prevents their otherwise excessive pressure against the cylinder. Fig. 2 shows Downie's packing as it appears in the January, 1903, issue, with the addition of holes *a a* through the flanges. The cavity *B* connects the joints and steam can flow in at one and around the piston to the other, and out. This leakage will be small, and if in the high pressure cylinder of a compound engine is not lost.

It is assumed that in Downie's packing the rings are placed in the grooves with their joints 180 degrees apart; are uniform in cross section (not eccentric); that their joints are uncovered, so that, say half as much pressure will be kept in cavity *B* as there is on the piston; that the ring and cylinder wear is to the ring and groove wear as 10 to 1; that the piston is at the top of the cylinder with the rings just comfortably in touch with it and their groove, and that all are of uniform temperature. We now admit steam at 200 pounds pressure to the top of the piston, with the result that the cylinder expands through the effects of pressure and temperature. Steam then enters cavity *B*, expanding the piston by its heat and forcing the rings to the cylinder and tight in their groove. At one-fifth stroke, steam pressure is cut off, and the cylinder contracts during the other four-fifths, and forces the rings to contract as much (except that which wears off) as the cylinder expanded owing to the pressure of the steam; so that the rings by the time they get to the bottom of the cylinder, bear the same relation to it and to the piston that they did at the top, except that they are a little nearer worn out. It will be noted that during this single stroke the rings were first forced out, then in, making two groove-wears to one on the cylinder. It will also be seen that this alternate out-and-in action of the ring will tend to wear the cylinder "barrel shape," and with constant pressure, point of cut-off and lubrication and perfect piston alignment, an ideal piston efficiency may result. If the groove wear should exceed the cylinder wear, the rings may be placed with joints coincident in their groove, so they will contract and expand as a unit. In any other position, they will wear on each other. With this packing there can be no groove wear due to impact, for the slight movement of the rings would only result in varying their degree of tightness. The pressure on the top flange of the piston will tend to close the groove, and tighten the rings in it. I do not see any reason why we may not make use of this condition and hold the rings in their grooves, with practically a constant pressure against the cylinder, by making slightly flexible flanges, and proportioning the ring so the radial steam pressure on it will be balanced by groove friction. A piston of this kind is shown in Fig. 3. It will leak at the joints of the rings, and after the point of cut-off, as the cylinder pressure is reduced, it contracts, and the ring is forced to contract, just the same as Downie's does, the principal difference being that only one ring is tight at a time, and as long as they do not stick in their grooves, they will make the piston practically steam-tight. I do believe, however, that rings held in their grooves as in a vise are more apt to score the cylinder than if free.

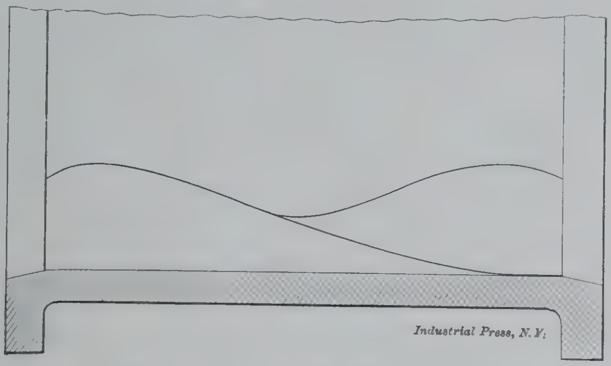
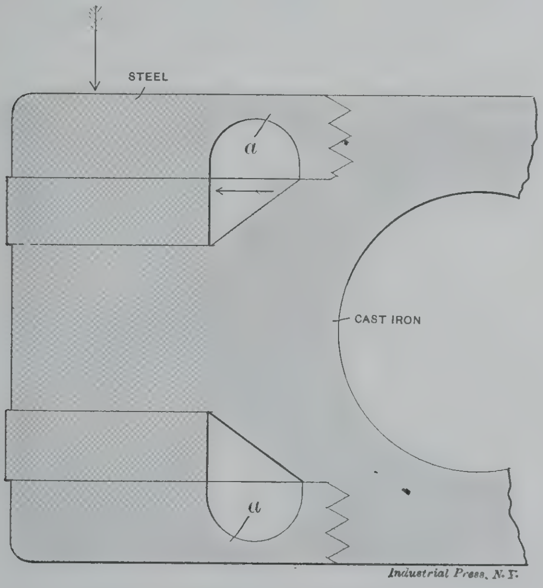

Industrial Press, N.Y.

Fig. 1. Diagram showing Piston Wear.

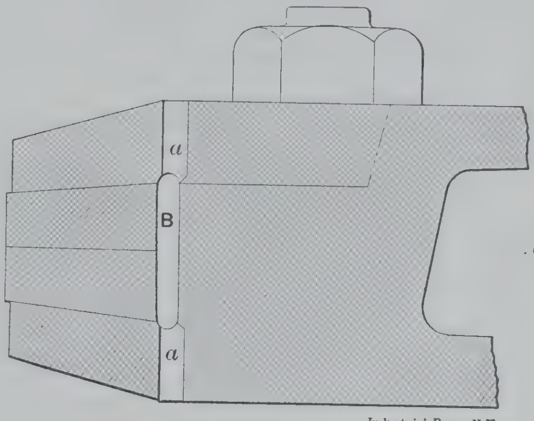
The next on my list is another English piston for marine engines, shown in Fig. 4, which the editor of MACHINERY clipped from the *Mechanical World* and kindly sent me. Its inventor, Mr. Berry, describes it as follows:

"*B* is a junk ring, loose on the piston body, and adjustable diametrically with setscrews *d*. It is also provided with springs *D* which force the packing rings *A A′* apart vertically. The latter are rings of rectangular section, whose ends are forced apart by springs *S* placed under the brass-joint pieces *M*, as shown. The ends of the ring are cut on an angle as usual, and are normally ⅛ inch apart. In order to prevent the steam finding its way to the back of the ring, care has been taken to block the water grooves at *a*, *a* and *b*, *b*." This packing is simple in construction, and has proved very efficient in practice. In support of this latter claim we were given an opportunity to closely examine the interior of the high-pressure cylinder, in which the tool marks were very plainly visible, although no lubricant had been used, and the vessel had steamed from Liverpool to Japan, thence to Australia, and thence to Europe, at an average piston speed of 650 feet per minute." Tool mark credentials may be of some value in determining cylinder wear, but they do not carry any evidence that the piston was steam-tight. It would be interesting to know if the tool marks were also visible on the packing rings, at the time the cylinder was examined. It will be remembered that Mr. Berry cuts his packing rings in sections, and sets them out to the cylinder with springs *S*, and out to the flanges, with springs *D*. Now I take it that springs *D* are stiff enough to resist the steam pressure tending to force them in an up-and-down direction; and as the joints are covered, there is no chance for steam to get under and force them out. Under such circumstances, if springs *S* are stiff enough to be relied on to keep the rings out, they are very objectionably too stiff when the cylinder has to set the rings in. Suppose that springs *D* require 100 pounds per inch of circumference of the rings to set them out, then it is plain that it will require 200 to set them in. In thinking this matter over I conclude that it would be exceedingly dangerous to run a piston dry in a cylinder, if its rings, or any other part could touch it with an appreciable pressure. I have heard of low-pressure pistons, say thirty years ago, being run without oil continuously without injury, but Mr. Berry's is the first high-pressure, that I have known of. There is a considerable difference between the way Mr. Berry clamps his rings in their grooves, and the way they are held in Fig. 3. It will be noted that the spring *D* produces nearly constant side pressure on the rings, while in Fig 3 it varies as the pressure on the piston, and when on the exhaust side of it, they are very nearly free to expand.



Industrial Press, N.Y.

Fig. 3. Piston with Flexible Flanges.



Industrial Press, N.Y.

Fig. 2. Downie's Packing.

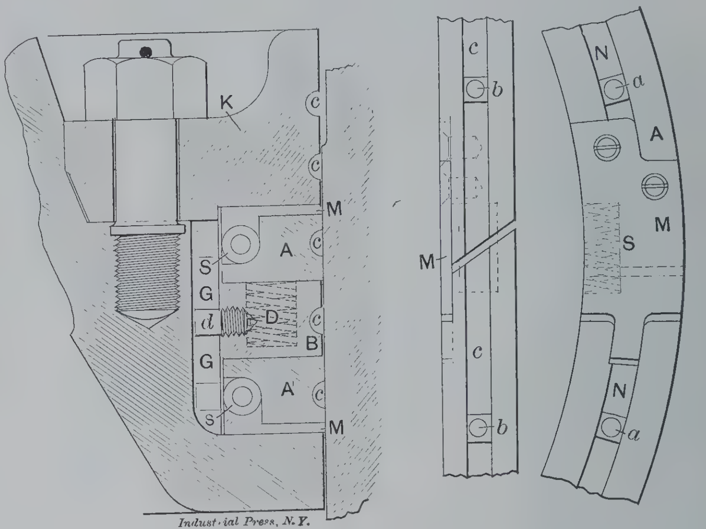
Of the many schemes to get a side pressure on packing ring the only one I have known of to be used considerably is beveling an inside corner of the ring, and then putting a wire spring in the groove, to act on the beveled surface of the ring. The London & Northwestern Railroad used brass rings in their pistons, set out as stated, in 1895. My report does not say if the springs acted to force the rings apart, and to keep the steam from under them, or on their opposite sides, just to stop their clatter in the grooves.

The reader will naturally expect a goodly number of originalities in anything that Professor Sweet designs, and I want to say right here, that the pistons of his Straight Line engines (a blueprint and catalogue of which he has kindly sent me) are a case in which the expected happens. I will begin by describing his packing ring, and that part within quotation marks is what he says of it.

On page 4 of the Straight Line Engine Company's catalogue we find that "limited expansion piston rings were conceived about 1884." I make this statement to show that Professor Sweet was among the first to see that steam would get under packing rings, if there were no special ports for that purpose. Still there are inventors scheming for some new way to give the steam a better chance to set the ring out, evidently believing that "steam-tight" means all the pressure on the ring that the cylinder will stand without bursting. It is to be hoped that the correspondence schools will show their scholars just how a packing ring packs, in a much clearer manner than the average text-book.

To counteract the internal steam pressure, Professor Sweet connects the ends of his rings with a tie piece, and to get the maximum and also uniform groove surface he makes the edges of his rings concentric and very materially adds to their uniform elasticity by making the central part eccentric, all as shown in his blueprint, Fig. 5. "The joint in the ring is held on the bottom of the cylinder by the pin in the tie piece and the steam is prevented from leaking by the bull ring which carries the load, shutting off the gap. The steam gets under the ring of course, but cannot force it out, owing to the limit tie piece. One unlooked-for favorable feature developed when we put these rings in practice. When starting the engines the rings have to open and close at the ends as they go in and out of the cold end of the cylinder. This hammers the hooks away very slowly, so that this just about compensates for the wear on the rings and it is seldom necessary to remove the tie piece and file away the hooks." This is certainly a fortunate condition, to have the hooks hammer or wear away just fast enough, making the length of the tie piece automatic, and is not at all unreasonable if we look at it rightly. It seems to me that an unmentioned source of wear on the hooks would take place when the tie piece was sustaining half the internal pressure on the ring. For the line of stress in the tie piece is above the neutral surface of the ring, which will tend to throw the ends at the joints down; and when the exhaust is opened at that end of the piston, they come up to their original position, causing a very slight rolling wear on the hooks twice to a revolution of the engine. No leakage will take place by this up-and-down pulsation of the points of the ring, for the bull ring will cover any gap within its arc of contact with the cylinder. The points of the rings, too, would soon wear to accommodate the spring, due to the pull on the tie piece. The reader will note that the faces of the hooks are not parallel, and that the way the tie piece is dowelled, if the bull ring wears faster than the packing ring, the tie piece is lengthened thereby. Perhaps there is some objection to a vertical stem on the tie piece passing up through the horizontal flange of the piston, forming a dowel pin, that I do not see. If there is, I beg pardon for making the suggestion.

The Straight Line engine cylinders are bushed, and I judge from the illustrations in the company's catalogue, that the bush and packing ring are of about an equal thickness, so that these two parts will expand about alike with both temperature and pressure. So there is nothing to prevent the packing ring from being just a touching fit with the cylinder at all parts of the stroke. Under such conditions, the ring wear would be the least that is possible, consistent with steam-tightness of piston, and while the hook wear (four surfaces) must be at least three times the ring wear, the hook surfaces may be proportioned, from experience, to just meet the requirements. If the hook wear should be too rapid, it would increase the ring pressure on the cylinder, and consequently increase their wear, and react by decreasing the hook wear. If, however, the ring wear should be too fast, there does not seem to be any remedy but to ease off the hooks. It seems to me that it would be advisable to test this piston occasionally for tightness; and while taking off the cylinder head and putting steam behind the piston is a good way, an easier way is to open the cylinder vents and blow the air out of it with steam when it is cold, then close the vents and throttle, and note by an indicator or vacuum gage attached to that end of the cylinder, how much vacuum is produced by the steam condensing. Of course this is only an inferential test, and to be of any value the vents, valve and throttle must be known to be tight.



Industrial Press, N. Y.

Fig. 4. English Piston for Marine Engines.

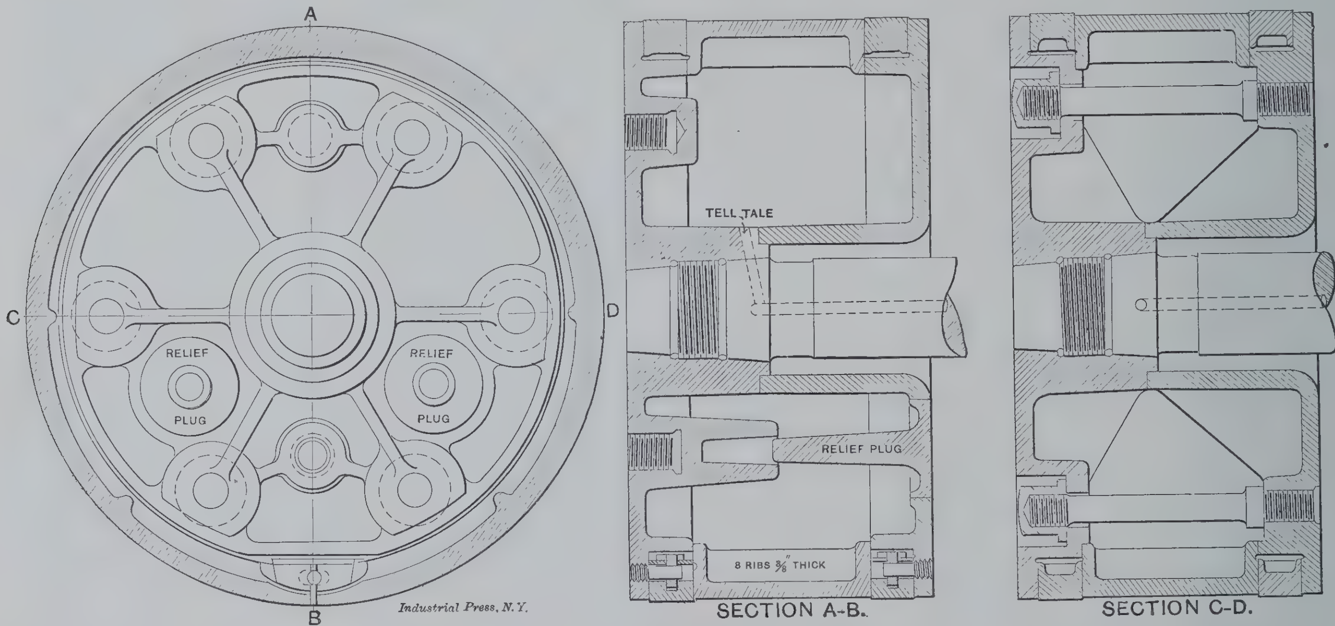


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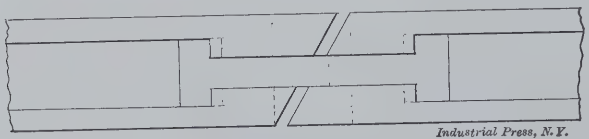
Fig. 5. Prof. Sweet's "Straight-Line" Piston.



Industrial Press, N. Y.

Fig. 6. Tie-piece on Inside of Ring.

In general design, Professor Sweet's piston is in a class by itself, as the reader will see by a glance at it. After describing his packing ring, he says:

"You will notice some other things about the piston—that it is light, that when it wears there is nothing to renew but the bull ring, that there are no cap screws to work loose and cause a smash-up, that the bodies of the studs are turned down so that the nuts never get loose on account of the elasticity of the studs, that the grooves are undercut so that the wearing surface in the groove is the same width as the wearing face of the ring, etc." Another feature of this piston is its relief plugs. In case too much water gets mixed with the steam, these plugs are forced into the piston, affording ample room for the water. The plugs are forced in the piston till they will resist a pressure of 200 pounds per square inch. When a plug is blown in, the engineer is notified by water flowing through the tell-tale, i e., a hole through the piston rod communicating with the interior of the piston. In reply to an inquiry, I learn that there is no partition in the piston, and that it has only happened once that the plugs at both ends of the piston were blown in at a time; then a half hour's shut-down was required. When the plugs at one end only are blown in, the engine is run just as though nothing had happened till an opportune time for replacing them.

There is one very good feature about these plugs; they don't bespatter everything in their cone of dispersion, as outside plugs do when they go off, and combined are big enough for any emergency, while usually single plugs are not. The Professor calls this his pop piston, and says "that the best thing about it is that it works when there is an occasion, which may be soon or never."

* * *

A. S. M. E. PAPERS

PRESENTED AT THE SARATOGA CONVENTION, JUNE 23 TO 26.

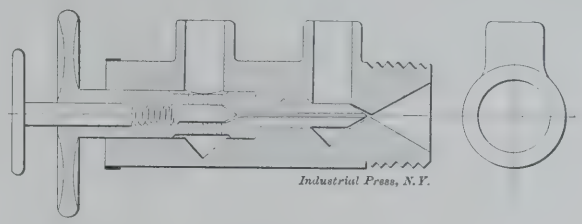
As we go to press the sessions of the summer meetings of the American Society of Mechanical Engineers are in progress at Saratoga. Elsewhere in this number two of the papers presented are reproduced nearly in full; one is summarized in the data sheet, and below are brief paragraphs upon the balance of the papers.

One of the most exhaustive of these was by Prof. C. H. Robertson, Purdue University, upon tests of a 12 horse power gas engine. This paper contains a record of tests by several students in the preparation of their graduating theses during a period of six years. The tests were designed to determine the effects upon the gas engine of changes in speed, load, point of ignition, ratio of gas to air, and jacket temperature. It is obviously impossible in the space at our disposal to give an adequate review of a paper of this character, in which extended detailed results of many tests are grouped together, and the same holds of several other papers to which we shall but briefly refer. Prof. Robertson's conclusions may be summarized as follows: Increase in speed from 150 to 300 revolutions results in increase in amount of gas per explosion, a proportionately less increase in mean effective pressure, and an increase in explosions per minute at constant power; a decrease in efficiency of 25 per cent., due in part to an increase of 2.20 horse power absorbed by friction; and a marked decrease in the per cent. of heat absorbed by the jacket and an increase in the per cent. exhausted and radiated.

With respect to the load, an increase from 0 to 10 horse power decreases the M. E. P. from about 94 to 82, and an increase in load from 2 to 10 horse power causes an increase in mechanical efficiency from about 37 to 78 per cent. In addition to these results there are conclusions with respect to the proportions of gas and air used, most desirable point of ignition and best jacket temperature. From the standpoint of the indicated horse power, the lowest gas consumption and the highest thermal efficiency are secured under the following conditions: Ignition between normal and late, jacket temperature, the lowest used, or 90 degrees; speed, the lowest tried, or 150 revolutions per minute; brake horse power, at about .6 the normal capacity of the engine.

There are two other gas engine papers, one upon an engine using gasoline and kerosene as fuel, by H. F. Halladay and G. O. Hodge, and "A Method of Testing Gas Engines," by E. C. Oliver. The first of these comprises the results of an exceedingly interesting series of tests on an Otto gas engine at the Clarkson School of Technology. The engine is nominally rated at 15 horse power and is designed for either gas or gasoline, a change of two valves being all that is required when desired to change from one fuel to the other. In order to use kerosene fuel, however, additional apparatus was required by which the oil could be sprayed into a heated chamber where it could be vaporized and the vapor superheated sufficiently to prevent the oil vapor condensing and depositing on the cooler walls of the ports and valves of the engine. It was found that if the vapor reached a temperature lower than 575 degrees it would at once condense. The temperature of vaporization of the kerosene was about 380 degrees and it was superheated on an average about 240 degrees.

The nozzle employed in spraying the kerosene is shown in the sketch herewith, *A* being the kerosene connection and *B* the connection with the compressed air. The nozzle delivered into a horizontal pipe under which Bunsen burners were placed. The most satisfactory conditions for the use of kerosene were found by adjusting the supply of the mixture of air and kerosene simultaneously with the regular air admission to the engine cylinder, so that the exhaust was smokeless. The heating value of the two fuels was 20,296 B. T. U. for the gasoline and 19,282 B. T. U. for the kerosene. The price of the former was 14½ cents a gallon and of the latter 14 cents. The rate of consumption was the same for both fuels at 4.5 brake horse power; under light loads the gasoline was the more economical and under heavy loads the kerosene. Averages of all the tests show that with kerosene the per cent. fuel converted into useful work was 16.5; while the per cent. gasoline converted into useful work was only 12.5. These results appear very favorable to the kerosene; but this is undoubtedly due in part, at least, to the fact that the kerosene vapor is superheated by the application of outside heat, which adds to the efficiency of the vapor.


Industrial Press, N. Y.

Vaporizing Nozzle.

The paper by Mr. Oliver upon a method of testing gas engines discusses a system of tests worked out by the author in the University of Illinois, and deals chiefly with the determination of the quantities of air and gas used, and the temperature of the exhaust gas at atmospheric pressure—quantities all difficult to calculate or measure by ordinary means.

The United States Army Gun Factory, Watervliet Arsenal, N. Y., was described by J. M. Scheele. Watervliet Arsenal was established in 1813 as a military establishment and field carriages and leather equipment were the most important products. A shop built in 1887 is now used for the manufacture of field and siege guns, which is a distinct department from the seacoast gun shop. The latter is a building 1,000 feet in length, with two wings, and equipped with 40 heavy lathes classified as gun lathes, jacket and hoop lathes, which are capable of handling guns up to 16 inches in diameter.

All boring, reaming, turning and facing operations of the tubes, jackets, large hoops and the assembled guns are performed in these lathes; short hoops are usually turned, bored and placed in regular boring and turning mills or in cylinder boring machines. Special machines are also available for the principal remaining operations on the gun, such as rifling the bore, threading and slotting the breech.

A large number of modern standard machine tools are used for making the breech mechanisms fitted to each gun. The metal employed in gun construction is low carbon steel, melted by the open-hearth process and cast into suitable ingots at the works of the manufacturers. The forgings as received at the army gun factory are tempered, annealed, and rough-machined all over. Approximately twenty per cent. to twenty-five per cent. of metal is removed by the various tools and appliances at the gun shop for producing the finished guns.

The machinists and all skilled mechanics are employed under the system of local civil service board, the civil service law being carried out strictly within the provisions of the government requirements, thus applying the merit system to all applicants.

Records are kept of each employee, which are examined from month to month. This method enables the board to investigate the employees' standing and efficiency, also to recommend an increase of wages and promotion to the next higher class for those who have proved themselves worthy.

The promotions are generally made quarterly. The machinists are divided into four classes—namely, the special class, the first, second and third; their wages ranging from $2.72 to $3.28 per diem for eight hours work, foremen not being included in these classes.

To each employee who has served not less than one year is granted fifteen days annual leave with pay, and all employees are paid for the general holidays.

What is, perhaps, the paper of greatest current interest is a description and test of a 400 K. W. turbo-generator of the Westinghouse-Parsons type, installed at the Yale & Towne plant, Stamford, Conn. The turbine end of this unit has been entirely satisfactory during the year or more that it has been in operation; it has required no renewals or repairs, and the bearings show no appreciable wear. But one-half gallon of oil is required per week. The only trouble that developed with the steam end was its liability to shut down when running from three-quarter to full load if by any chance the vacuum became destroyed. A device for automatically preventing this, however, is to be adopted.

The electrical end of the unit was not so satisfactory. At first the generator field gave trouble and was replaced and the new field proved defective and burst—difficulties that do not affect the turbine question.

Answers are given to a number of questions, some of which are briefly as follows: It does fulfill the guaranteed economy; the noise is not excessive nor disagreeable; the continuity of operation is satisfactory; the exhaust can be used for heating purposes; it can be changed from condensing to non-condensing with ease, and this is done daily; the exciter should be driven by an independent engine; the cost of such a generating outfit is ten to fifteen per cent. less than an equivalent reciprocating engine; the vibration is not at all excessive. The paper closes with a number of boiler, economy and motor tests.

There is no doubt that the alternating current is gaining in favor over the direct current in electrical distribution and would make more rapid strides were it not for lack of speed control features. A paper by W. L. Slichter upon alternating current motors for variable speed is therefore of considerable interest.

The speed of an alternating current motor may be controlled in a number of ways:

(*a*) By varying the potential applied to the primary of a motor having a suitable resistance in the secondary.

(*b*) By varying the resistance in the secondary circuit.

(*c*) By changing the connections of the primary in a manner to change the number of poles.

(*d*) By varying the frequency of the applied voltage.

The characteristics of the alternating current motor are very similar to those of the continuous current shunt motor —that is, at a constant impressed voltage and frequency the speed tends to be constant, and a considerable change in load will not cause an appreciable change in speed. As the load increases, the speed drops gradually to a critical point, usually about 15 to 20 per cent. below the normal value, and then the motor breaks down completely if the load is any further increased. The same action occurs exactly if the load is kept constant and the voltage is decreased. But if the frequency of alternation of the impressed voltage is decreased, the speed will decrease in exactly the same proportion. That is, for a given frequency and a given number of poles in the motor, the speed is practically fixed and independent of all other effects.

The one exception to this last rule is the effect of the resistance (or losses) in the secondary (usually the rotating) member.

The drop in speed from the synchronous value is directly proportional to these losses. Thus, by increasing the resistance of this circuit, any desired speed may be obtained at the expense of these losses. With the increased resistance, the speed at which the motor breaks down may be reduced to a very low value, even to zero speed. Thus, by reducing the voltage applied to the motor for a given torque, the effect is produced of overloading it, and the speed drops.

Of the various methods of speed variation, the changeable pole and variable frequency methods are the most efficient, but do not permit of a variation through a wide range of speed. The rheostatic control is the simplest and easiest of control, giving a range from standstill to full speed, but is not as efficient as the first two, although more efficient than potential control. The last mentioned has the disadvantages of low efficiency and considerably increased heating in the motor itself, and is also unstable at low speeds, say below one-third speed. That is, a small variation in torque or a smaller variation in voltage will cause a considerable variation in speed.

The potential control is used where moderate variations in speed are wanted, not reaching to less than half speed for instance, and where the load is intermittent, not giving the motor a chance to get too hot. Its great disadvantage is the amount of current it takes at starting, which causes considerable disturbance in the supply circuit, flickering of lights, etc.

Mr. A. H. Eldredge, an occasional contributor to MACHINERY, has two short papers, one describing a hot well of special design, which also served as a very efficient oil extractor; and the other on the desirability of positive governor drives for Corliss engines. The first shows that a hot well, properly proportioned, will extract the oil discharged in the exhaust, through the condenser, on the principle of the oil rising to the surface and draining off at the top, while the feed water is pumped out at the bottom. The second paper describes two governor drives, one by means of shafts and gears and the other by means of a Morse rocker chain, which had displaced unsatisfactory belt drives and caused the engines to run much better than they had previously.

Prof. D. S. Jacobus summarizes the results of tests on a Rice and Sargent cross-compound engine, having cylinders 20 and 40 inches by 42 inches stroke. The clearance for the high-pressure cylinder was 4.7 per cent. and of the low-pressure, 7 per cent. There was a reheating receiver and the cylinder heads were jacketed. The water consumption per indicated horse power per hour varied from 12.10 pounds at 627.4 horse power to 12.75 pounds at 1,004.3 horse power. At 491.4 horse power the water consumption was 13.92 pounds, and at 339.7 horse power it was 14.58 pounds. These figures represent the total water consumption, including that used by the jackets and reheater coil.

The balance of the papers are either somewhat out of the field of MACHINERY or else are of such a character as not to be susceptible of condensation in the form of an abstract, and their titles are given herewith: A Drawing Office Equipment, by John McGeorge, of the Wellman-Seaver-Morgan Plant, Cleveland; Test of a Hydraulic Elevator Plant, by R. P. Bolton; Rational Train Resistance Formula, by John B. Blood; Turbine Flow Recorder (already described in a previous number of MACHINERY), by Chas. M. Allen; Some Data on Hoisting Hooks, by John L. Bacon; Strains Produced by Excessive Tightening of Nuts, by A. Bement; Indicating Anglemeter, by C. E. Sargent; Graphical Daily Balance to Manufacture, by H. L. Gantt; Shop Management, by Fred W. Taylor; The Machine Shop Problem, by Chas. Day; Experiment Boiler of Ohio State University, E. A. Hitchcock; Mechanics of Air Brake Systems, H. G. Manning; Comparative Oil Tests, W. F. Palish; Test of Eight-Foot Fan Blower, by R. P. Bolton.

* * *

A correspondent to the *Scientific American* announces a wonder of wonders, being no less than the discovery of how to always have a sharp razor. His plan is to always strop his razor while as hot as it can be made by dipping in boiling water, and to use it when cold. The theory advanced is the somewhat fanciful one that the contraction of the edge makes it appreciably keener. In this connection it may be mentioned that it is considered bad practice to place keen-edged tools like razors, surgical instruments, etc., in boiling water for any great length of time as the edge is thereby dulled. Therefore, never boil your razor.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The new Fisk street power station now building in Chicago for the Chicago Edison Station, is planned for 14 Curtis vertical steam turbines direct-connected to General Electric generators of 5,000 kilowatt capacity each. The present structure is being built for only four turbines, but the extension for the other ten can be made in harmony with it when required, or if the turbines are found unsuitable, a slight change will permit the installation of reciprocating engines. The boiler house is arranged in units, each containing eight Babcock & Wilcox boilers to supply two turbines, having 5,000 square feet of heating surface and carrying a pressure of 175 pounds. The steam is to be superheated to 150 degrees above that normal to its pressure. The nominal boiler rating for each turbine is 4,000 boiler horsepower.

A recent computation has placed the total aggregate power of steam turbines in use or under construction or ordered in different parts of the world at over 500,000 H. P. Of this total the major portion is used or to be used for the driving of dynamos, alternators, or other electrical machinery, while the next in importance is marine engines. The Metropolitan District Railway Co., London, England, have recently contracted with the British Westinghouse Electric & Mfg. Co. for four turbo-alternators. Each of these machines is designed for a normal capacity of 5,500 kilowatts, but will be capable of carrying an overload of 50 per cent., giving for each unit a maximum output of 8,250 kilowatts, or about 11,000 E. H. P. These turbines will be not only the largest steam turbines ever made, but also the most powerful single cylinder engines of any type whatever in the world. Very few multiple cylinder engines existent have greater power. Notwithstanding the enormous power they will develop, the dimensions of these engines are only 29 feet in length, by 14 feet wide, by 12 feet high, the over all length of turbine and alternator being 51 feet 9 inches. The steam pressure will be 165 pounds per square inch, and the speed 1,000 R. P. M.

The *American Shipbuilder* describes what will be the largest river steamboat in the world—the *C. W. Morse* now building at the shipyard of Harlan & Hollingsworth, Wilmington, Del., for the People's Evening Line, to ply on the Hudson River between New York and Albany. The new vessel will closely follow the lines of the *Adirondack*, but will be larger in every way, the length being 430 feet and breadth over guards, 96 feet. The hull will be constructed of mild steel as will be the deckhouse up to the saloon deck. The motive power will be a W. A. Fletcher & Co. walking-beam surface condensing engine of 4,500 horse power connected to Morgan feathering paddle wheels. The fittings of the staterooms and saloons have many up-to-date features that will enhance the beauty and elegance of a floating palace, and conduce to the comfort and pleasure of passengers. An entirely new feature on Hudson River boats will be introduced on this vessel, and that is outside ventilation for all staterooms. All the staterooms will be furnished with iron and brass bedsteads which, in the better rooms, will be double width, giving, with the other appointments, all the comfort and luxury of a first-class hotel. The new vessel will be launched in June and will be ready for service with the opening of the season in 1904.

In a paper read by Alex. Dow, before the National Electric Light Association, at Chicago, May 26-28, a comparatively new means of utilizing the exhaust steam of electric light and power stations, was referred to; that is to evaporate brine, salt thereby being made a by-product. In Michigan near Detroit exist extensive salt beds and this condition has led to the innovation outlined in the paper—the manufacture of salt as an adjunct to a power station. The possibilities of this scheme seem to promise more than the use of exhaust steam for heating. When used for the latter purpose there is a demand for it only during the winter months; the salt making may go on the year round, and if any emergency arise its use can be suspended without raising a public clamor. It is pointed out that if electric power can be made sufficiently cheap, and the cost during the daylight hours be regulated to stimulate a demand for it at that time and reduce the peak of the load, there will undoubtedly be in almost any community, especially one like Detroit, a demand for power throughout the whole twenty-four hours. Now a salt-making plant can be profitably utilized to absorb the heat in the exhaust steam and the returns from the salt sold will, it is claimed, wipe out the cost of the coal.

In a paper read by A. D. Williamson on the application of electricity at the works of Vickers Sons & Maxim, before the Institution of Electrical Engineers, May 7, the author discussed the problem of variable-speed motors. He said that the subject had received much attention within the past few years, and that there is now no difficulty in making efficient motors that can be varied with a range of 3 to 1 by varying the field excitation. A range of 3 to 1 seems to be about the most economical one for motors of fair size, say, from 250 to 750, or 300 to 900 revolutions per minute for motors from 5 to 30 horse power. The firm above mentioned are building motors which work sparklessly with fixed brushes with a speed variation of 3 to 1. In connection with this portion of the paper a novel application of the variable-speed motor was mentioned which is used in the same works. A portable vertical planer or slotting machine is driven by a 5 brake horse power motor with a range of speed from 300 to 900, the motor being attached direct to the machine. On the cutting stroke the motor runs at its slowest speed, and at the end of the stroke, the length of which is easily adjusted to suit the work, the motor reverses automatically. As soon as the reversal has occurred a resistance is automatically inserted in the field winding, quickly raising the speed to 900 for the return stroke. At the end of the quick return stroke, immediately before reversal, the field resistance is short-circuited, providing a strong field for reversing in, and the motor reverses and makes its slow cutting stroke, the cycle repeating itself. The insertion and removal of the field resistance necessitates a special form of switch, which is provisionally protected and cannot at present be described in detail. The arrangement has been in use for some time successfully, and it is anticipated that it will be of great use in driving many types of reciprocating machines. In actual practice it is found that this method of driving is very economical and possesses advantages over the usual belt reversing drive, as the excess current at reversing can be reduced to a negligible quantity.

COOLING AN AUDITORIUM BY AIR PASSING OVER ICE.

As the hot weather comes on, any method by which sweltering humanity can keep cool when the mercury is in the nineties, must be of interest, especially if they must attend crowded entertainments. A paper was read by John J. Harris at Atlantic City, N. J., before the American Society of Heating and Ventilating Engineers in which he described a method by which an auditorium at Scranton, Pa., has been cooled during the commencement exercises for the past two years, by forcing air over racks of ice. The moisture was controlled by the use of calcium chloride. The auditorium which has a seating capacity of 900 was kept at a temperature of 76 degrees with the outside temperature at 90 degrees, and that when the room was crowded with 1,400 persons. The size of the room is 80 x 80 x 20 feet high, and the amount of ice melted averaged about 13,000 pounds for each of the three nights of the exercises. The fans delivered 3,000,000 cubic feet of air per hour through the ducts and over the racks upon which the ice was laid. A plenum fan and an exhaust fan were used to create the circulation. The racks were built with five shelves consisting of slats through which the air currents could freely circulate. The calcium chloride was disposed in shallow pans having perforated bottoms so that the accumulated moisture could drain off readily, and in this connection it should be mentioned that the calcium chloride must be chemically pure in order to be effective in removing the moisture from the air.

The movement is now well under way for a memorial to commemorate the first successful iron works in America. The memorial is to take the form of a monument to be erected in Taunton, Mass., where the first iron masters, James Leonard and Henry Leonard, started in business in 1653. The remarkable development of the iron industry in recent years and the interesting history of its establishment in this country have caused iron men to be deeply interested in the project. The initial steps in the matter were taken at a meeting of the Old Colony Historical Society, held in the city of Taunton. The descendants of the first successful iron masters who started in business in Taunton in 1653 were called together under the auspices of this society, and as a result of that meeting an executive committee was appointed for the purpose of securing funds and superintending the erection of a memorial to mark the introduction of this great industry in America.

The design for the monument is by Charles Henry Niehaus, the eminent sculptor. There is to be a shaft of granite 75 feet high, at the base of which are sculptured figures, representing the rugged pioneers of the iron industry. The shaft will be topped with an electric star as the symbol of the Light of Industry. There are to be legendary figures of heroic size placed at the four angles of the monument representing four of the Greek gods, among them being Vulcan. The design is pronounced by those who have seen it in the sculptor's studio to be in every way worthy of the subject which it commemorates.

AIR-PUMP EXHAUST.

American Electrician, June, 1903.

In an article on steam plant auxiliaries Mr. Henry C. Meyer, Jr., expressed the opinion that it is poor practice to connect the air-pump exhaust to the condenser in order to give the steam cylinder of the air-pump the benefit of the vacuum, provided there is not sufficient exhaust steam from the other auxiliaries to heat the feedwater to about 200 degrees F. In such cases it is much more economical to use the air-pump exhaust for heating the feedwater than to turn it into the condenser. In the first case nearly all the heat is returned to the boiler with the feedwater, but if turned into the condenser most of it goes to waste with the air-pump discharge.

RE THE METRIC SYSTEM.

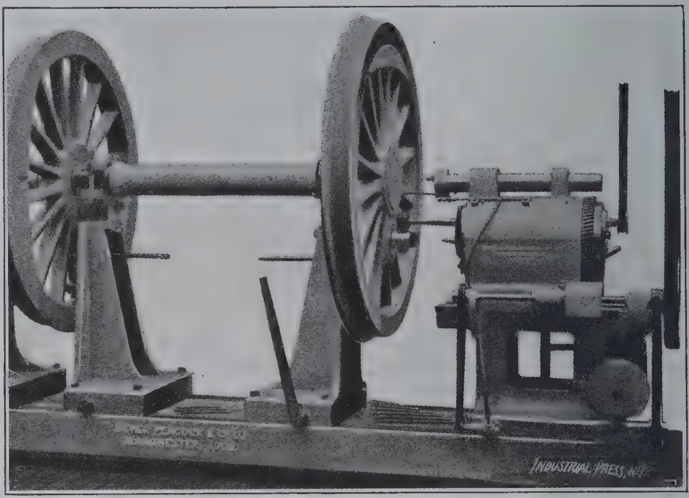
Electrical World and Engineer, June 13, 1903, p. 1,005.

In the days of old Rome, all numerical values, and therefore all quantities, such as sesterces, talents, sheep, or oxen, were written down in Roman numerals. The addition or multiplication of quantities thus symbolized was a task of relatively tremendous magnitude. Even the professional clerks, trained to the yoke, had to employ the abacus to help them. The labor wasted in the Roman system by the community aggregated a heavy tax. The Arabic system of numerals, which is now international, came to the Roman empire from the East. It offered enormous saving of labor, and rendered all weighings, measurements, records, and bookkeeping much easier. Every man could reckon for himself. But the Arabic system was only introduced after a long and protracted struggle against the fanaticism of the "sweating calculators" who opposed the innovation by every means in their power. In England at this date there appear to be very many intelligent men who oppose the introduction of a decimal currency such as ours, and advocate the retention of their ridiculously cumbersome and labor-creating system of pounds, guineas, shillings, florins, crowns, half-crowns, sixpences, threepenny bits, pence, half-pence, and farthings. The arguments they offer bear a gruesome likeness to those which are offered by the anti-metric system conservatives in this country.

LOCOMOTIVE CRANKPIN GRINDING MACHINE.

Engineering (London), April 17, 1903. p. 507.

In article No. XIX. of the series "Grinding Machines and Processes," Mr. Joseph Horner describes a locomotive crankpin grinding machine of the sun-and-planet order, made by Beyer, Peacock & Co., Manchester, Eng. In this machine the drivers are mounted on columns or brackets provided with vees at the top into which the bearings are firmly clamped. Adjusting screws are provided in the brackets for varying the height of the drivers relatively to the grinder head at the right, and pilot centers on an outside bracket at the left and on the grinding head give means for exact adjustment. In this machine the emery wheel, of course, slowly revolves around the pin while it rapidly rotates on its own axis. Means are provided for varying the degree of eccentricity to suit pins of varying diameters, etc. The machine is said to do work of high precision and excellent finish.



Special Grinding Machine.

HIGH PRESSURE GAS DISTRIBUTION.

In a paper read by George F. Goodnow before the second annual meeting of the Wisconsin Gas Association, held in Kenosha, Wis., February 11-12, 1903, the author referred at length to the experience gained from the operation of a high-pressure gas distribution system in the town of Waukegan, Ill. The pressure carried is about twenty pounds per square inch, and regulators are employed at each lamp post and in each residence to reduce the pressure to that normally used. The reason for using high pressure is that much smaller distribution mains can be employed. Roughly speaking, a 1¼-inch pipe main will carry as much gas at a pressure of 20 pounds as a 4-inch pipe at the ordinary low pressures; and a 2-inch high-pressure main as much as a 6-inch low-pressure main. If the pressure was 30 pounds the capacity would be at least 50 per cent. greater. The leakage is not perceptibly greater than with low pressure. A gas compressor is, of course, used for getting the high pressure. The success of this example of high-pressure distribution of manufactured gas (natural gas has been distributed under high pressure from the beginning) may lead to important developments in the general scheme of gas manufacture and distribution in great cities. If it is practical to convey manufactured gas through mains under high pressure, why cannot the gas be manufactured at the coal mines and conveyed to the market by pipes instead of being hauled there in the shape of coal by railroad cars? It is not too much to expect that one of the developments of the twentieth century will be the elimination of the railway from the distribution of fuel to the eastern cities of the United States.

REHEATERS AND SUPERHEATING.

American Electrician, June, 1903.

In an article on steam engines for electric power stations Mr. George I. Rockwood says that it has not yet been demonstrated that superheated steam effects any real saving of coal. None of the plants of which we have heard so much within the past five years, especially designed to use highly superheated steam, has shown anything like the economy of coal of the Atlantic Mills plant, although they have shown phenomenal reductions in the weight of steam used per horse power per hour. The superheating not only eats up all it saves, but it increases friction and wear, and adds heavily to the first cost and running expenses of the plant. In the No. 4 mill of the Atlantic Mills referred to, at Providence, R. I., there is a small Corliss, compound, condensing, slow speed engine of about 500 horse power which gives one brake horse power on a coal consumption of 1.2 pounds per hour, and a steam consumption of 11.2 pounds per hour. That superheating does not effect a practical saving when the cost of doing the superheating is taken account of, is shown by the tests of the Cooper-Corliss engine at the Atlantic Mills, both with and without steam in its receiver. With steam in the jacket pipes the temperature of the receiver steam was raised 44 degrees above that normal to its pressure. No saving of heat whatever resulted, however, except the hot jacket drip that was returned to the boiler. The test proved, nevertheless, that a reheater increases the power of an engine without lowering its economy, the increase being about 12 per cent.

HEATING AND VENTILATING THE MACHINE SHOP.

Paper read by J. I. Lyle, of the Buffalo Forge Co., before the New York Railroad Club.

The fans installed in hot blast heating systems differ very materially in their design. Two types of fans are used for heating; the disk or propeller type, and the centrifugal or steel plate type. The latter is used almost exclusively, as the disk fans, except for very small installations, have not been a success. With the centrifugal type of fan, the most economical results for heating are obtained when running the fan in coldest weather at a speed so the periphery of the wheel will travel at a velocity of approximately 4,500 to 5,200 feet per minute. In no part of the fan system design does practice differ so greatly as in construction and location of the hot air ducts. Several schemes are used, the most common being to construct the ducts of galvanized iron and to carry the horizontal runs overhead through the truss work, with warm air outlets spaced from 15 to 40 feet apart, these outlets being placed from 8 to 20 feet above the floor.

In the early installations the idea was to distribute very thoroughly, through ducts running practically all over the shop, a relatively small volume at a high temperature and to discharge it 6 feet or 8 feet above the floor and direct it so it would blow on the workmen. This practice resulted in much adverse criticism of the fan system, as the workmen in the line of the discharge were given colds and would be overheated, while those not in the direct path would not be heated sufficiently. The later practice for large shops has been to use large volumes of air at rather low temperatures and to use much shorter pipes and to allow the air to travel freely in the building for some distance. The outlets are usually from 10 feet to 20 feet above the floor. In this design advantage is taken of the fact that the warm air discharged high up travels toward the walls where it is cooled and becoming heavier falls to the floor; thus the walls assist the circulation. The direction of the winds largely determines the coldest side of the building and as the temperature of the wall will control to a certain extent the air currents, the coldest wall will cool the greatest amount of air, consequently the more air will be drawn in that direction. With the older installations of thorough distribution this was not accomplished so well and generally one side of the shop would be better heated than the other. Another advantage in placing the outlets high is that no air currents are felt by the occupants on the floor. Heating plants in machine shops are in successful operation now where the air is discharged 100 to 175 feet from the ends of the buildings, and in foundries it is blown as far as 250 feet.

Masonry or concrete ducts placed under the floor with stand-pipes located at intervals and extending above the floor, from 8 to 12 feet are in many cases used. In the Brown Hoisting Machinery Co., Cleveland, O., shops, the underground concrete duct is used and connected to the hollow steel columns supporting the building, which are used for the risers, discharging the air about 4 feet above the floor. In the Philadelphia & Reading shops, at Reading, Pa., no distributing pipes are used, but the hot air is discharged from the fan into the building overhead and the air returned to the apparatus by means of underground ducts with openings at the floor line and distributed through the shop.

The velocities of the hot air in the main ducts leading from the fans should never be greater than 2,500 feet per minute, and this velocity should be reduced gradually in the different branches so that the air is discharged from the outlets at from 800 to 1,200 feet per minute. Where the outlets are high, as in large buildings, 1,200 feet per minute can be used without any objectionable results; but where a thorough distribution is desired, and the outlets are placed within 6 or 8 feet from the floor, the velocity of air from the outlets should not be greater than 800 feet per minute.

In any shop installation, provision should be made for recirculating the air, and for the use of cold fresh air from the outside of the building. Occasionally it is found that a building can be heated easier by using part outside air and part return air than to use all return air. This is accounted for in the following way: Where the fan is blowing into and exhausting from the building, as in recirculating, the pressure maintained in the building is not greater than the outside, so the leakage of air around windows, doors, and crevices may be very great, while by the use of a part of fresh outside air a slight pressure can be maintained and to a large extent prevent this inward leakage. In either case cold air will of course be entering the building, but in the latter case the outside air will pass through the heater where it can be heated more economically and easier than by mixing it with the heated air in the building as it leaks in. In some cases it is found difficult to maintain uniform temperature throughout the buildings when using entirely return air, because it is difficult to keep the lower strata of air along the floor sufficiently warm, owing to leakage, though in the upper part of the building the temperature may be as high as 80 or 85 degrees. Because of the influence of local conditions, fan makers hesitate to give out data about their apparatus. The capacity of the steel plate centrifugal exhaust fan (inlet on one side only) when running under "free delivery" will be given approximately, however, by the formula:

$$C = 1.57\ D^2WR.$$

In which $C =$ capacity in cu. ft. per minute. $D =$ diameter of blast wheel in feet. $W =$ width of the blast wheel at the periphery in feet. $R =$ R. P. M.

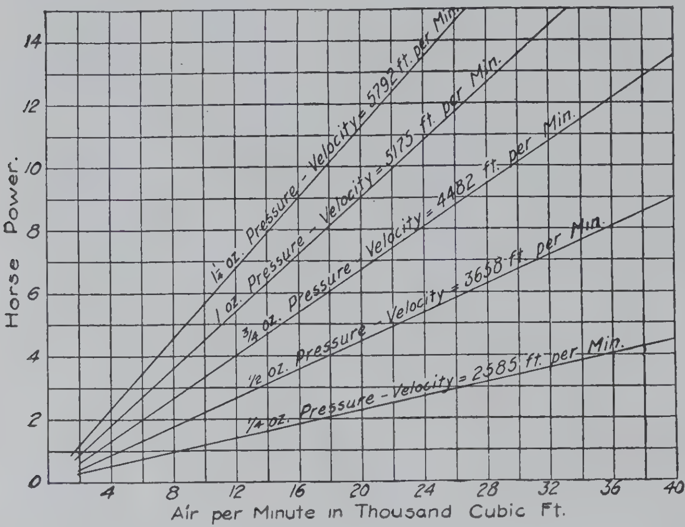
By "free delivery" is meant to set the fan in the room and simply draw the air into the inlet and discharge into the same room without any piping, thereby avoiding ducts with the attending friction, other than the air passing through the fan.

In factory buildings where short pipes of rather large diameter are used, thus reducing the friction, the formula $C = 1.25\ D^2WR$ will be found to be approximately correct. With long ducts terminating into many small outlets, the capacity will reduce from 10 per cent. to 20 per cent. as given by this last formula.

The delivery or capacity of a fan within the limits used in heating, varies directly as the speed of the fan. In a good installation with the fan running with a peripheral velocity of 5,200 feet per minute (approximately 1 ounce pressure with air at 62 degrees), from 2,200 to 2,500 cubic feet of air per minute will be delivered per horse power expended.

By proportioning the fan to meet the severest conditions of weather, say zero or colder, then in moderate weather of 20 degrees to 25 degrees above zero the fan will do the work easily at three-fourths the speed, the delivery varying with the speed; and the horse power will be reduced more than one half, giving 3,850 to 4,300 cubic feet of air delivered per minute per horse power. As the number of zero days during the winter are comparatively few, it will be found in the majority of cases that the cost of power to run the fans on such days at one ounce pressure is less than the interest on the increased cost of a larger fan designed to operate at a slower speed in the severest weather.

As to whether a steam engine or electric motor is the better for driving the fan depends upon the local conditions. If there is not sufficient exhaust steam to do the heating, an engine-driven fan is the more economical as its exhaust can be used. Fully 75 per cent. of the heat of the steam supplied to the engine is available for heating, as the cylinder condensation and expansion will not amount to more than 25 per cent. An engine-driven fan also has the additional advantage of being independent of the electric plant; so the heating plant can be operated when the electric plant is shut down. Where electric current is constantly available together with sufficient exhaust steam, an electric motor is the most convenient and economical, as it is probable the electric generating units in such cases are large and consequently more economical than a small steam engine. If the fan apparatus is placed very far from the source of steam supply, the condensation in high pressure steam pipes necessary for an engine is an item well worth saving. Where engines are used it is better to have them direct connected, but belted electric motors are preferable because of the large and expensive motor necessary for direct connection on account of the slow feed of the fan.



The curve shows the horse power required to move a given volume of air at different velocities or pressures.

THE CONVERSION OF ALTERNATING INTO DIRECT CURRENT.

Electrical Review, May 23, 1903. p. 203.

A recent editorial in the *Electrical Review* describes the various methods of transforming alternating electric currents into direct currents. Briefly they are as follows: 1. The motor-generator in which an alternating current motor drives a direct-current generator, the two being coupled on the same shaft. 2. The rectifier which is a commutator driven by a synchronous motor. Since the synchronous motor keeps step with the alternating current generator from which it is supplied, the commutator also runs in step, so that by feeding the current by means of slip rings, the current impulses can be sorted out and supplied to the secondary circuit always in one direction, just the same as is done by the commutator of a direct-current dynamo. 3. The synchronous converter which is a synchronous motor fitted with a suitable commutator, may act as an alternating current motor and as a direct-current generator, and it can do both at the same time. The alternating current is first transformed down to the proper voltage and then supplied to the machine through slip rings to drive it as a synchronous motor. From the same winding by means of the commutator a direct current may be drawn. 4. Leblanc's converter is a peculiarly wound transformer connected to a stationary commutator upon which revolving brushes, driven by a small synchronous motor, press. 5. The electrolytic rectifier or electric valve depends on the property of certain metals in solution, allowing current from them to flow in one direction freely, but presenting considerable opposition to flow in the opposite direction. Attempting to pass an alternating current through a series of such combinations will cut out every other half wave and transmit a series of impulses all having the same direction. The opposite impulses may be sorted out in the same way and sent through the same circuit, thus giving a continuous direct current. 6. The Cooper-Hewitt mercury vapor converter is similar to the electric valve in that it allows the current to pass through it in one direction only. 7. The rectifying arc employs the repulsion of a magnet to an arc to separate the positive from the negative half waves. One electrode of an alternating current arc is split into two parts and insulated. The repulsion of a magnet brought near causes one set of waves to pass to one half of the electrode and the other set to the opposite half.

THE AMERICAN WORKMAN FROM THE ENGLISH WORKMAN'S POINT OF VIEW.

Page's Magazine (London), June, 1903. p. 532.

The American workman as he appears to an English workman is graphically sketched in a short article in which the writer tells in his own way the story of his experiences in American shops, and records his impressions of American workmen. His preliminary word about employers is a good illustration of the true proverb that "Familiarity breeds contempt." "On first acquaintance," he says, "American shops and America generally, have a charm for almost everyone, and it depends on a man's temperament whether he falls permanently in with it or becomes hostile. I was struck favorably first with the genial and courteous manner of employers. Next I found they were always like it with strangers. Then I found they were practically on a level with the men, and expected to be spoken to in the same familiar way, and took it quite as a matter of course if their word was distrusted, or if they were abused or threatened."

The author's impression of the men themselves was at first favorable. "It was evident that in some ways they were on a higher level than the English workman, and except that they worked harder and longer, it was not apparent in what they could be worse off. Sixty hours a week, after the English fifty-four, seemed very hard, although I was getting nearly double English wages. It seemed remarkable, too, that, although the day was so long, and made worse still by dividing it into two long spells with only a more or less brief interval for dinner, that the work should be pursued diligently from the moment of starting until stopping time. The signs of hustle that I had expected were not noticeable, but even in the slowest shops there was practically no loafing. The general impulse seemed to be to turn out the work in the quickest and most straightforward way. Even with scarcely enough work in the shop, there seemed to be no holding back. Everyone made himself as comfortable as possible, but the work didn't stop. If it suited a man to sit down at what he was doing he sat down, and often spent more of the day seated than standing. If he was hungry he could spread quite an elaborate meal on the bench and eat as he worked. He is particular about temperature, and, in spite of the enormous variations outside, most shops are kept about the same all the year round—rather warmer than most Englishmen like, but the American reckons to work comfortably with coat and waistcoat off when the weather is at its coldest outside. Outside workers take more pains to protect themselves, and in very severe weather stop work altogether where possible."

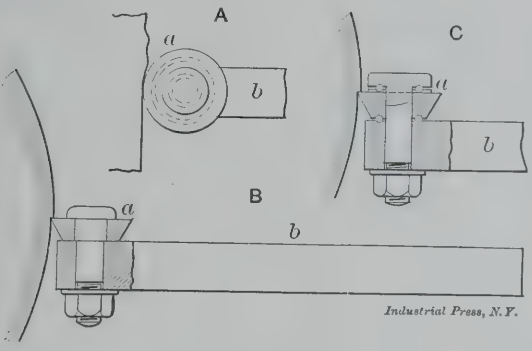
"The American workman's standard of living is unquestionably higher than the English, and would remain so, even if he went in as much as the Englishman for beer. He eats less in quantity, and less frequently, and does not enjoy eating much, but there is more variety in his food. It costs about the same in England, but, no doubt, considerably more is spent on it. He dresses better, and lives in a better house. Comparatively few men care to go through the streets from work with dirty faces and hands and clothes. In some cases they make an entire change night and morning in the shop, so that outside they are as well dressed as a business man. The time, however, during which they can appear like this is brief. As with work, so with relaxation. It cannot be taken in so leisurely a manner as here. Holidays have to be taken in a very sober fashion, for the custom is to have one day only at a time, and start promptly at the regular time next morning."

CIRCULAR TOOL FOR TURNING HARD CAST ROLLS.

Der Praktische Machinen Konstrukteur, April 9, 1903, page 66.

Heinrich Stadler, of Turn, states that in the turning of the hard rolls of the machines it is a disagreeable experience that good hard turning steel will not stand up to the work. Consequently, much time is lost in the removal, grinding and replacement of the same. In order to remedy this trouble he has made an application of the circular cutter so extensively used in the paper industry.

The arrangement used for this purpose is clearly shown in sketch at *A* and *B*, where it is shown set in a movable tool holder *b*, which is, in turn, held by a toolpost. At the same time the little wheel *a* must be free to turn, while at work, upon its bolt. On the other hand, it is essential that it should stand still, except for the action of the side pressure due to the feed by which the rate of revolution of the wheel is regulated.



Circular Turning Tool.

As with other tools, the wear of the wheel after a short time must always be taken into account, so that it should be crowded into the work to a corresponding extent.

By the simultaneous use of two such wheels a remarkable increase of efficiency can be obtained. Furthermore the durability in service is from thirty to thirty-five times as great as with the standard form of turning tool. On the other hand, there is the disadvantage that heavy cuts cannot be taken.

According to the author, the revolution of the wheel can be greatly facilitated if it is carried on ball bearings, as shown at *C*.—G. L. F.

THE MANUFACTURE OF SEAMLESS BOILER TUBES.

Journal of the Society of Naval Engineers, May, 1903.

In this article the author, Lieut. Newton Mansfield, refers to lack of endurance of boiler tubes in modern marine boilers carrying high pressures. Tests have been made on specimens of charcoal iron, cold-drawn mild steel, hot-drawn mild steel, and lap-welded steel boiler tubes immersed in distilled water through which air was percolated. These tests, made independently by officers of the United States Navy, showed that hot-drawn steel tubes free from millscale, showed the least corrosion, although the superiority over the cold-drawn and lap-welded steel tubes was not very marked. It was stated that nickel-steel having from 30 to 35 per cent. nickel is practically incorrodible, and has been used for some time in France for the boiler tubes of torpedo boats and destroyers. It is of prime importance that the interior of tubes be smooth and free from millscale, and as the use of this tubing is to be extensive in our navy in the future, the process of manufacture by which this and other desirable features are obtained, is given at considerable length, from which the following is taken:

The material is mild, open-hearth, basic steel taken from the bottom half of the ingots and received at the tube mill in round bars of from three to four inches in diameter and from eight to ten feet long, having an average tensile strength, 52,400 pounds per square inch; average elastic limit, 30,400 pounds per square inch, average elongation, 25 per cent. in eight inches, and average reduction of area, 56 per cent. The approximate chemical composition is: Carbon, .17 per cent.; manganese, .45 per cent.; sulphur, .025 per cent.; phosphorus, .01 per cent.

The manufacture of the tube is comparatively simple, yet of such a nature that none but the best product should finally reach the finished state. The process may be divided into two parts, viz:

1. The hot treatment.
2. The cold treatment.

The Hot Treatment.

The round bars of steel are heated to a cherry red in a closed gas furnace, and are sawed at this heat, by a circular saw, in length commensurate with the required length of the finished tube. These sawed lengths are not allowed to cool, but are immediately put into another closed gas furnace and heated to a light-yellow heat. This second heating is gradual, the time required being from twenty to forty minutes. The distillation of bituminous coal is used as the gas for heating. The "billets," as the sawed lengths are now called, are placed in the coldest part of the furnace and rolled from time to time in the hottest part, so that every part of the billet may have the same temperature. The billets upon reaching the required temperature are taken out and delivered to the piercing mill, the principle of which is shown in Fig. 1.

The piercing mill consists of two disks of cast steel carried on the ends of two shafts whose center lines lie in the same horizontal plane, but slightly inclined to each other. The shafts revolve in opposite directions and make one hundred and twenty revolutions per minute. The faces of the disks may be brought nearer to each other or separated by adjusting screws to accommodate billets of different diameters.

The billet in its yellow-heat temperature is laid on a small guide between the faces of the disks so as to bring the axis of the billet in the same horizontal plane in which the axes of the disks lie. The billet is then pushed by hand until its forward end takes against the revolving disks. The principle of the belt climbing to the high side of the pulley forces the billet on to the piercing point, which is shown in Fig. 1.

The piercing point pierces the billet while the beveled surfaces of the disks roll the pierced billet out smoothly as it advances over the piercing point. The piercing point and its mandrel are firmly supported so that the piercing point enters the center of the billet. This is not held rigidly in place, however, but is allowed to revolve with the billet. Its rear end is held in a swivel amply strong to take the thrust of the advancing billet. After each billet is pierced, the piercing point and its mandrel are dipped in cold water to lower their temperature. (Both disks are constantly cooled by a stream of cold water.) The piercing point is made of the hardest steel. The piercing of a billet is a severe test of the homogeneousness of the material.

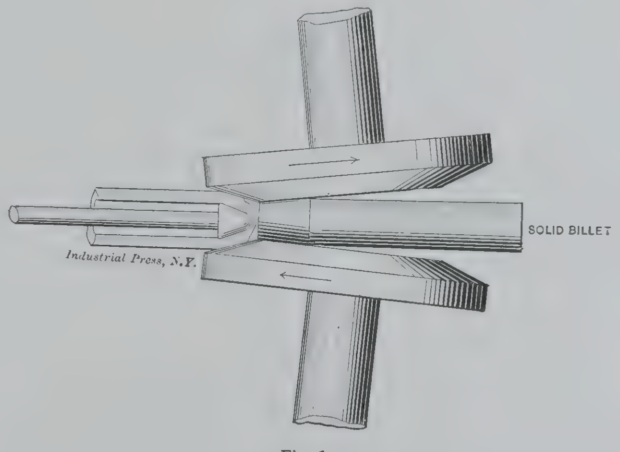


Fig. 1.

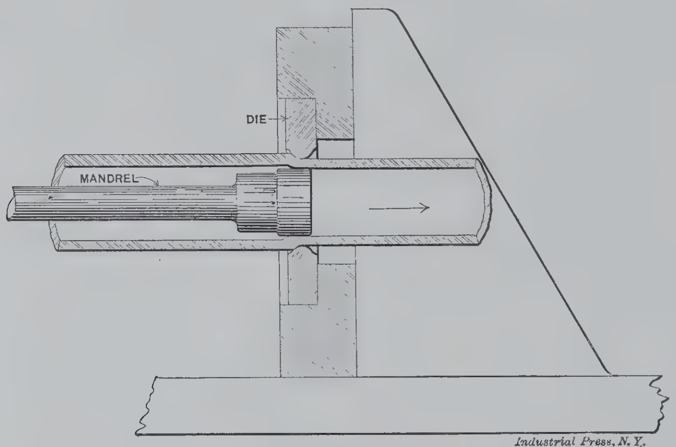
The range of temperature within which a billet must be pierced is very small. If the metal is too cold, the billet is sometimes torn or will stop the mill; or if too hot, the resulting tube may be very rough and contain injurious spiral twists. If the temperature is just right and the billet is in every respect a good one, it goes through the mill smoothly, coming out with a central longitudinal hole, fairly smooth on the inside and carrying considerable millscale on the outside surface.

The billet is now about twice its original length. It is not allowed to cool, but is passed immediately through the rolls.

The rolls are the ordinary cast-iron rolls used in steel mills, but as the tube is rolled it is made to slide over a mandrel, whose point is held between the rolls. Should the "tube," as it is now called, cool too much for rolling, it is placed in a convenient furnace to receive the proper heat, but this is not done except in very long tubes that cannot be rolled with the one heat of the piercing mill. The tube is given from four to eight passes through the rolls, care being taken that the tube is turned through about ninety degrees after each pass, in order that the walls may be rolled of even thickness. The tube is now about four or five times the length of the original billet and has a wall of about one-quarter inch in excess of the required thickness in the finished tube, while the excess in diameter over the finished tube is about one-half inch. There is little or no mill-scale on the inside, but considerable on the outside. This ends the hot treatment.

The Cold Treatment.

The tube, coming from the rolls with a fairly smooth surface on the outside and a smoother surface on the inside, is allowed to cool to the temperature of the air. It is then pointed. This is done by heating one end of the tube for a length of about one foot and crushing from six to eight inches of this heated end in a pneumatic hammer, forming a point so that the end of the tube may be started through a die of smaller diameter than the tube. This die is shown in Fig. 2. This point serves as a gripping surface for the pliers which pull the tube through the die.



Industrial Press, N. Y.

Fig. 2.

The tube, having been pointed, is taken to the pickling room and immersed in a hot, though weak, solution of sulphuric acid. This pickling removes the scale. After this immersion in the bath of hot sulphuric acid the tube is immersed in a bath of fresh water which washes away the loosened scale. The tube is then immersed in a mixture of tallow and paste, the paste being made of flour and hot water. This last operation, is called "dopeing." After "dopeing" the tube is dried for about five minutes in a hot oven. The tube is now ready for the cold-draw bench room.

The Cold Drawing.

The principle of the draw bench is shown in Fig. 2. The tube at its pointed end is closed, but the other end is open. Into the open end the mandrel is shoved until the mandrel takes against the pointed end on the inside of the tube. The mandrel is carried on one end of a long rod, the other end of which is secured to the draw bench to hold the mandrel in its proper position relative to the die. The pointed end of the tube with the mandrel on the inside is now passed into the die and the drawing pliers are made to grip the point. They work on the principle of ice tongs. Toes on the pliers engage in an endless sprocket chain which, traveling at the rate of ten feet per minute, slowly draws the tube through the die. The tube having passed through the die is reduced in diameter, being reduced in thickness and lengthened about 20 per cent. Both inside and outside surfaces are smooth, almost polished.

The effect on the tube undergoing the process of cold drawing, is good evidence of the quality of the material. If the material be of meager ductility the tube will tear in two, and if the material be not homogeneous, it will show in the surface as spongy spots, checks or small transverse tears. It will be noticed that the mandrel in Fig. 2 has no side support other than the metal of the tube. By reason of this, hard spots easily displace it in drawing which shows up on the inside surface. The tube is always drawn beyond its elastic limit. After the tube has made one pass on the cold-draw bench it is annealed in an open furnace which uses the distillation of bituminous coal as a source of heat. The temperature of annealing is that of cherry red, but may be so regulated as to affect the ductility and tensile strength within certain well-known limits. The tube having reached the required temperature is taken from the oven and allowed to cool in the air, after which it is again pickled and immersed in the mixture of "dope," and dried. It is now ready for a second pass on the cold-draw bench.

The number of times a tube is drawn on the cold-draw bench depends on 1, the thickness of the wall of the finished tube; 2, the tensile strength of the material of the tube; 3, the tensile strength of the rod holding the mandrel in its relative position to the die.

It is seen that in the cold drawing the pliers tend to pull the tube apart at the die, causing a tensile stress at the die which must be resisted by the tensile strength of the material in the tube. The ability of tubes to resist this tensile stress is manifestly greater in tubes of thick than thin wall, considering the area of the cross section of the tubes as resisting surface. It must not be forgotten that, as the tube is drawn through the die, and the metal is "sunk" around the mandrel, the friction between the inside of the tube and the mandrel tends to pull the mandrel through the die. This is resisted by the tensile strength of the mandrel rod.

In reducing a tube from a larger to a smaller diameter and from a thicker to a thinner wall, it must be borne in mind that required reduction must not be obtained by a pull equal to the tensile strength of the tube; and, further, the friction between the inside of the tube and the mandrel must be less than the elastic limit of the mandrel rod. If these two conditions are fulfilled the tube may be drawn safely.

Large tubes of thick wall, therefore, do not require so many passes on the draw bench as tubes of smaller diameter and thinner wall. For instance, the 2-inch, 8 B.W.G. that are now being manufactured for the boilers of our ships receive but two passes on the cold-draw bench. In the first pass the diameter is reduced from 2½ inches to 2 3-16 inches, while the wall is reduced from 5-16 (.3125) inch to 7-32 (.21875) inch. The second pass further reduces the diameter from 2 3-16 inches to 2 inches and the wall from 7-32 (.21875) to 8 B.W.G., or .165 inch.

A tube of 1 inch diameter and 11 B.W.G., as is used in the boilers of our torpedo boats, requires at least five passes. The reductions of diameter are from 1½ to 1⅜, 1¼, 1 3-16, 1⅛, and 1 inch respectively, while the five passes reduce the thickness of the wall at the same time to the following dimensions, viz.: from ¼ (.25) to 7-32 (.21875), 3-16 (.1875), 11-64 (.171875), 5-32 (.15625), and 11 B.W.G. (.120) inch. Then follow inspection, hydraulic test under 1,000 pounds pressure, retort annealing and final inspection.

* * *

In his engineering reminiscences, now being published in *Power* and the *American Machinist*, Mr. Charles T. Porter refers to his experience in introducing the Richards steam engine indicator, which eventually supplanted the McNaught and Hopkinson indicators then in use (1863). It was earnestly desired that the new instrument should be so accurate and generally reliable as to command the respect of the engineering fraternity, as much depended upon the result of the venture. The problem of making the cylinders of the indicators so that each should have a diameter of .7979 inch, giving an area of .50 square inch, was solved by having a steel mandrel 20 inches long ground by the Whitworth Co. exactly parallel and to the internal diameter required for the cylinders. Brass tubes slightly larger in diameter which had been carefully cleaned, were drawn down on this mandrel. When pressed off they presented an internal surface, perfectly smooth and true to gage. The tube was then sawed up into lengths of about two inches for each cylinder.

HIGH-SPEED LATHE WORK.

Abstract from paper read by H. M. Norris before the Cincinnati Metal Trades Association.

The gist of this paper is that a great range of cutting speed in an ordinary engine lathe which is to be used on a certain class of work, like shafting, that does not vary greatly in diameter, is not well adapted to getting the maximum efficiency from the best high-speed steels. In Cincinnati most of the machine tool builders are specialists and they put through their work in large lots. It is quite essential that each operation should be performed at the maximum speed the material will permit, as whatever percentage of time can be saved on one piece, can be saved on the entire lot. The question is asked: How can the greatest amount of metal be removed by a Novo tool in the most economical manner?

If a shaft is to be reduced ¼ inch, should it be done in one cut or in two cuts? Should we use a fine feed or a coarse feed? Should we operate at a periphery speed of 150 feet or at 300 feet? The tool will stand so much and no more. What is this "so much?" Is it reached at a speed of 10 feet less than that at which the tool is ruined, or at a speed of 20 feet less? It is probable that the lasting qualities of a tool depend upon the amount of heat that is generated at its cutting edge. If this is true, it is also probable that the life of the tool is shortened with every increase in either speed, feed or depth of cut. But which generates the more heat—a deep cut under a fine feed or a shallow cut under a coarse feed? If we can settle this point the question will resolve itself down to a matter of periphery speed. Of course the tools will vary, so will also the material upon which they operate; but by making all the tests upon shafts cut from the same bar, and repeating each three times with different tools, we should be able to obtain a line on at least one of the laws that govern high speed cutting. This, then, is obviously our starting point, and inasmuch as the average run of our work will not permit our taking a cut in which the cross section of the chip is greater than ⅛ x 3-64 inch our test had best be confined to cuts of 1-16, 3-32 and ⅛ inch in depth by 1-64, 1-32 and 6-64 inch in thickness. The question, therefore, is to find the maximum speed at which the tool will operate under each of these cuts. How can this be determined? If we had a sufficiently powerful variable speed countershaft the speed could be increased as the cut advanced; but how would we know at what speed we were running at the moment the tool gave way? We know that on some work a Novo tool will stand a speed of 180 feet; so we might run a minute at 190, another minute at 200, and another at 210, etc., but the cuts would hardly be of sufficient duration to prove much. Then, too, having 27 tools to ruin, it would consume too much time. But what is the objection to operating on a conical shaft? The tools will probably be destroyed at a speed between 200 and 400 feet. This means that the large end of the shaft would have to be twice the diameter of the small end. If the length is kept within 24 inches we can use a taper attachment.

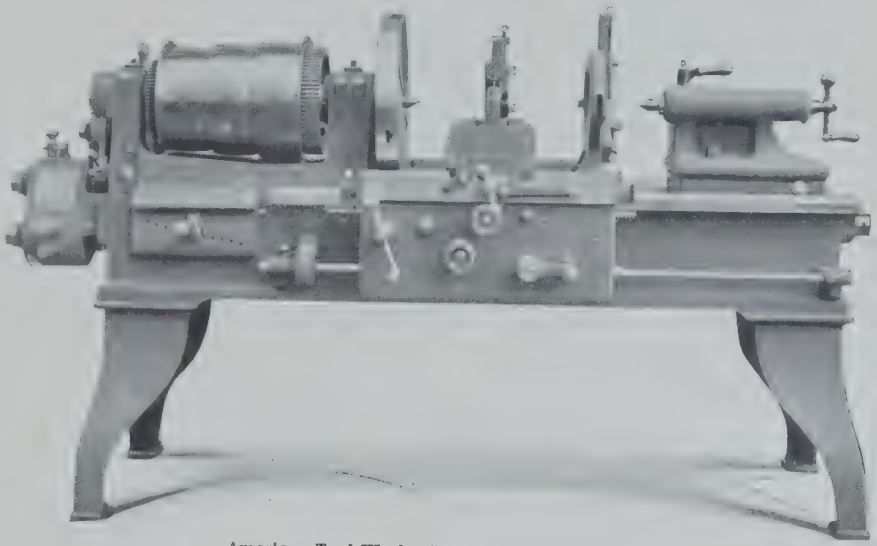
TABLE I. CUTTING SPEEDS.

	1	2	3	4
Feeds.	$\frac{1}{64}$	$\frac{1}{32}$	$\frac{3}{64}$	Average
Cut.				
$\frac{1}{16}$	326	320	381	342.3
"	425	360	327	370.6
"	339	354	330	341.
1 Average	363.3	344.6	346	351.3
$\frac{3}{32}$	326	230	262	272.6
"	368	268	209	281.6
"	332	285	227	281.3
2 Average	342	261	232.6	278 5
⅛	336	259	231	275.3
"	326	260	220	268.6
"	310	267	240	272.3
3 Average	324	262	230.3	272.1

TABLE II. CUBIC INCHES OF STOCK REMOVED.

	1	2	3	4
Feeds.	$\frac{1}{64}$	$\frac{1}{32}$	$\frac{3}{64}$	Average
Cut.				
$\frac{1}{16}$	3.822	7.502	13.40	8.241
"	4.982	8.440	11.50	8.307
"	3.974	8.299	11.60	7.957
1 Average	4.259	8.080	12.166	8.168
$\frac{3}{32}$	5.732	8.089	13.821	9 214
"	6.471	9.425	11.025	8.973
"	5.838	10.023	11.975	9.278
2 Average	6.013	9.179	12.273	9.155
⅛	7.8785	12.144	16.274	12.089
"	7.643	12.192	15 474	11.769
"	7.268	12 52	16.88	12.222
3 Average	7.597	12.285	16.203	12.0069

Six taper shafts were made from the same bar of steel and tested in the manner outlined. Table 1 gives the cutting speed at the moment the point was destroyed, and Table 2 gives the cubic inches of steel being removed at the same time. Tests made under water showed an average of less than 10 per cent. increase of speed, which is regarded as a distinct advantage, considering the trouble we would be put to if it could be demonstrated that water greatly increased the efficiency of the tool. Some of the conclusions reached by the tests are summarized as follows:



American Tool Works Co.'s High-Speed Lathe.

1. That a tailstock center made of Novo steel is much longer lived than the centers furnished by the manufacturers.
2. That after a tool has been burned its end should be cut off at least a 16th inside the burnt portion.
3. That white chips do not indicate that a tool is operating at less than its maximum speed.
4. That each successive cut on a shaft permits of a higher cutting speed than the previous one.
5. That while water may be beneficial as a check on the expansion of work its other advantages are too slight to warrant our using it in general practice.
6. That until such time as means are devised for compensating for the expansion of the work it is inexpedient to operate on the average grade of steel at a speed greater than 175 feet per minute.

Next in order for consideration is the question of how to avail ourselves of the high efficiency of these tools. None of our shafting is larger than 4 inches, and little of it smaller than 1 inch, so if a cutting speed of 175 feet per minute is the maximum speed at which we should attempt to operate, it will be unnecessary for the lathe spindle to run faster than 668 revolutions per minute or slower than 167 revolutions per minute.

It is possible to so grade the speeds between these limits that by employing 12 speed changes none will be so much as

10 per cent. lower than the desired speed of 175 feet per minute. These speeds are obtained by means of a three-step cone, with diameters varying only by small amounts and a back-gear ratio of 2.13 to 1, and a two-speed friction countershaft.

Comparing such a lathe with one of ordinary pattern, having five steps ranging from 4 to 12 inches, and back gear ratio of 12.35 to 1, we find that the latter is entirely unsuitable for high-speed cutting.

It has been shown that the maximum speed need be but four times faster than the minimum speed, while on this machine the maximum speed is more than 111 times the minimum speed. If, therefore, the lathe is speeded so that its maximum speed will cut a 1-inch shaft at the rate of 175 feet per minute, it will obviously require a diameter of 111 inches to maintain the same cutting speed when running at the minimum speed—which is rather a large piece to swing in an 18-inch lathe. And what is true of the slowest speed is true of six of the others. There are but three speeds adapted to work between 1 and 4 inches in diameter; a 3⅛-inch shaft has to be turned at the same speed as a 4-inch, a 1⅞ at the same speed as a 3, and a 1⅛ at the same speed as a 1¾. Now let us see what this means to us in the course of a year if both lathes were kept employed on 1⅛-inch work. Allowing 55 hours to the work and 50 weeks to the year makes a run of 2,750 hours. Taking wages at 20 cents per hour, and general expense at 25 cents per hour, makes the output of each lathe cost .45 × 2,750, or $1,237.50. Assuming the selling price of this work at 1¼ times what it cost to produce on an ordinary lathe, gives us a return of 1¼ × 1,237.5, or $1,546.88, which we will call the market price of 109 finished shafts. This brings us to the following proposition. If a lathe operating at a cutting speed of 109 feet per minute turns out 109 shafts per year, how many shafts a year can be turned out on a lathe operating at a cutting speed of 174 feet per minute? If we disregard the time consumed in handling the work, the answer is 174 shafts, or 59.6 per cent. more than can be turned out at the lower speed, in which event we would receive for the year's output 1.6 × 1,546.88, or $2,475. The cost, however, remains as before, but instead of profits being but $1,546.88—$1,237.50, $309.38, they are $2,475 — $1,237.50, $1,237.50, or or more than four times as large.

This, however, is an extreme case, as the average cutting speed on our special lathe is but 22 per cent. more efficient than the average cutting speed on the standard lathe, so at such times as the lathes are employed on a variety of diameters it is not likely that the profits on the product of the special lathe would be more than twice those earned on the product of the standard machine. But all of this is based on the assumption that the standard lathe has sufficient power to remove a chip of the same sectional area as the special lathe. We were told at the last meeting that the belt on a 36-inch lathe driven by a 45-inch pulley slipped under a cut of 1-16 x 1-32 inch, which would indicate that the ordinary 18-inch lathe will not begin to stand the cuts we can take on our special lathe. Why is this? How do we obtain so much more power? If we ask the builder if a certain lathe is powerful enough to perform certain work, he will answer: "Yes, it is geared in the ratio of 12 to 1," or he will say: "It's the highest geared machine on the market, which gives it power to burn." What, then, can we expect from a lathe geared in the ratio of 2 to 1? Let us see.

The maximum speed of both lathes is the same; each runs at 668 revolutions per minute. A 4-inch pulley running at this speed gives a belt travel of 699.53 feet per minute, which, multiplied by the width of the belt, gives a surface speed of 145.71 square feet per minute, as against a surface speed of 672.23 obtained from a 4-inch belt running on an 11 17-32-inch pulley. The surface speed of the one is to the surface speed of the other as 4.61 is to 1, so if both lathes are driven by belts of equal thickness the available power of the special lathe will be 4.61 times that of the ordinary lathe. It is a well-known fact, however, that a heavy double belt will not operate to advantage on a 4-inch pulley. It is also a fact that a double belt will transmit ten-sevenths the power of a single belt, which increases the power of a special lathe to 6.59 times that of the ordinary lathe. Then, too, there is the gain due to the additional arc of contact. In the ordinary lathe this arc is approximately 133 degrees, while in the special the arc is approximately 179 degrees, which increases our power to 8.87 times that of the ordinary lathe. "But how about the ratio of the back gears?" asks the lathe builder. The back gears? What have they to do with it? Is there any combination of gears in the world that will enable a machine to perform more work than the belt supplies power for? Here, then, is where the lathe builder falls down. He knows that the greater the ratio the greater the cut, but entirely overlooks the fact that where power is obtained at a forfeiture of speed the greater the ratio the greater the curtailment of profits.

[The lathe used by Mr. Norris in making these tests was the new "American" high-speed lathe, manufactured by the American Tool Works Company, Cincinnati. The lathe is particularly adapted for work from one to four inches in diameter and differs from the ordinary lathe in that it is designed throughout to meet the special requirements of modern high-speed tool steels. The limit of work is placed at the tool rather than at the belt, and with this in view, the apron, carriage, and bed, and so on have been given exceptional strength, and the headstock enormous belt power—such that the contact of belt when on the smallest step of the cone is greater than in the ordinary 36-inch lathe. The cone is so designed that a four-inch double belt can be shifted to any of the three steps with the greatest facility. There are twelve changes of speed so graded that a cutting speed of 160 feet per minute or thereabouts can be maintained on work ranging from 1 inch to 4 inches diameter. The bearings, owing to the high spindle speeds, are of unusual size, made of phosphor bronze, and are self-oiling. The makers are prepared to build headstocks similar to the above, but specially adapted to individual requirements. The leadscrew is placed on the inside of the bed and the feed box will give 44 changes for feeds or for screw cutting, without having to remove a single gear.—Editor.]

* * *

ITEMS OF MECHANICAL INTEREST.

A FILE FOR BRASS—STRENGTHENING A CHIMNEY—MILLING HEXAGON BOLT HEADS—FLEXIBLE CABLE HANGER—VALVE-MOTION MODEL.

A watch fitted with a balance wheel made of the nickel-steel alloy known as "invar," has been tested at the Kew observatory and given a certificate denoting wonderful time-keeping qualities. The mean variation of daily rates for one degree Fahrenheit, was only 0.004 second. "Invar" may be obtained from J. H. Agar Baugh, 92 Hatton Garden, London, E. C. Recent tests made at the National Physical Laboratory at Teddington and the International Weights and Measures Office at Sevres on "invar" bars of two grades, between the limits of 41 and 86 degrees F., showed a variable coefficient, the limits being 0.00000063 and 0.00000088 with a mean of about 0.00000073 per degree F.

That the opportunities for labor-saving are present in almost every business, is undoubtedly true, but it often takes a genius to discover them. How many persons have been observant enough to note the trouble and time required for the letter carrier to unload a letter box filled with mail matter? That some inventor has been, is evidenced by letter boxes that may be seen in the streets of at least one New England city. They are made with a hinged bottom and provision is made for hooking the mouth of the mail sack over the bottom so that when the lid is released the contents of the box drop into the pouch in the "twinkling of an eye."

At the Chemical Congress held in Berlin during the first days of June, great interest was manifested in the wonderful properties of polonium, the new element discovered by Prof. and Mme. Curie of Paris and publicly displayed at the Congress for the first time. The amount shown was only 15-100 grain, but it required two tons of uranium to produce it, and cost about $75, or at the rate of $2,880,000 a pound. Polonium is said to intercept electric sparks when placed between the electrodes. Pieces of barium, platinum and zincblende placed near polonium in a darkened room, glow with a bright, greenish light, giving visual evidence of peculiar radiations of great power.

A FILE FOR BRASS.

The *Mechanical Review* describes in one of its recent issues a new type of file, specially devised for working upon gun metal that has been introduced into the engineering department of the Chemin de Fer du Nord, France. The feature of this tool which distinguishes it from the general type of file is a series of shallow channels which cross its face diagonally at an angle of 30 deg., and placed about half an inch apart. The raised portions of the surface of the file between these channels are occupied by the teeth of the tool. The advantages of the file are that it clogs less rapidly, and can easily and quickly be re-sharpened on the sand-blast, while it increases the work of the engineer who uses it in connection with gun metal filing, by 30 per cent.

STRENGTHENING A CHIMNEY.

Some time ago at a certain railroad shop, the chimney showed signs of weakening when it became necessary to enter it with a new and enlarged breeching adapted for an increase that had been made in the boilers and engines. In order to prevent a collapse, the lower portion of the chimney was banded in six places with heavy bands tightened by bolts in the same way as tank bands are set up. Three were also put near the top and in this way the structure has been so strengthened that it is apparently as stable and solid as a new chimney.

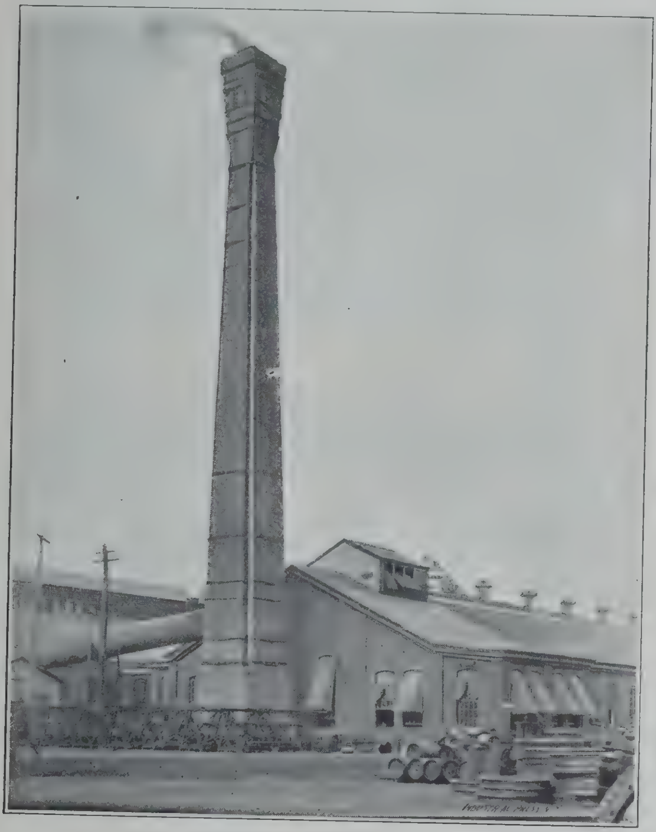


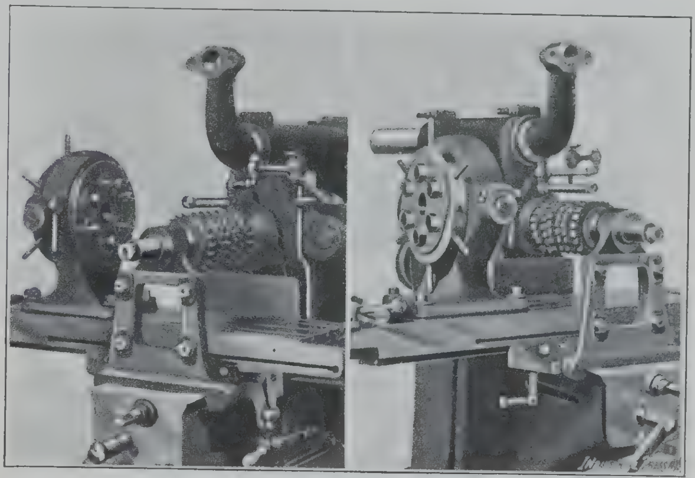
Fig. 1. Chimney Strengthened with Bands.

FORMULA FOR COLORING BRASS.

To produce a black color on brass Edwin S. Sperry gives a formula in *Metal Industry* as follows: Dissolve one pound of plastic carbonate of copper in two gallons of strong ammonia; first boil the brass that is to be blackened, in a strong potash solution to remove all grease and oil; rinse well and dip in the copper and ammonia solution, which should be heated to 150 to 175 degrees F., until the desired degree of blackness is acquired. The color produced is very uniform and has little tendency to peel off. The process works best on brass containing much copper, or on what is known as "red" brass. Directions are also given for making the plastic carbonate of copper as follows: Blue vitriol (sulphate of copper) is dissolved in hot water and a strong solution of common washing soda is added to it so long as any precipitate forms. The precipitate is allowed to settle and the clear liquid is poured off. Hot water is now added and the mass stirred and again allowed to settle. Again the clear water is poured off and the operation of adding hot water, settling and pouring off is repeated until everything has been washed out of the green carbonate of copper which remains at the bottom of the vessel. This is the plastic carbonate of copper referred to.

ENGLISH METHOD OF MILLING HEXAGON BOLT HEADS.

The *Engineer* (London) says that the method illustrated in Figs. 2 and 3 is one that is employed in the works of Alfred Herbert, Coventry, for milling the sides of hexagon nuts and bolt heads. Six cutters are mounted on the milling machine spindle so as to straddle three bolt heads at one time.



Figs. 2. and 3. Multiple Bolt Head Milling.

The bolts are held in a special fixture carrying six chucks mounted in a revolving frame or turret. Since two sides of three bolts are milled off at once, it is obvious that in effect one bolt head is milled complete at one operation, and indexing the turret one complete turn finishes six bolts or nuts. The bolts are inserted in the upper chucks, and, of course, the finished work is removed when it comes around to the same position. The cutters used on ⅝ inch bolts are 6 inches diameter and run at 46 turns per minute with a feed of ½ inch per minute. The output of ⅝ inch bolts, is about 35 per hour.

SIMPLE CABLE HANGER.

The different steps indicated in Fig. 4, show the method of applying an exceedingly simple device for supporting electric cables from steel suspension wires as is necessary where cables have to be carried in a long span between supports. The hanger is shown in *A*, and is a strip of zinc perforated at the bulbed end with two slots. *B* shows the first wrap around the cable; *C* the second wrap around the cable and

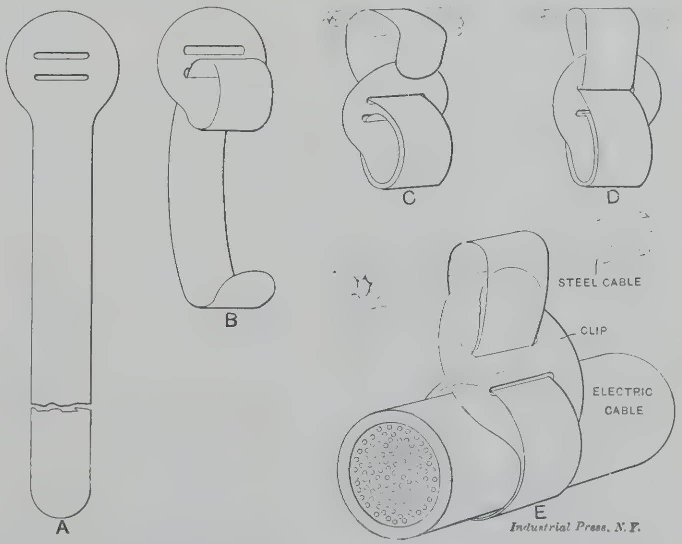


Fig. 4. New Hanger for Suspending Cable.

wrapping around the suspension wire; *D* the end tucked through the upper slot and turned up; and *E* the completed and assembled job. It is apparent that the weight on the tucked-in loop has a tendency to lock it tightly and prevent slipping. The device as a whole appears to be a very ingenious, simple and effective means of securing a desired result.

COLVIN'S VALVE MOTION MODEL.

Steam engine valve-gear, its functions and the successive events of a cycle altogether make a subject for absorbing study in which the designer, practical engineer and all others interested in the mechanics of the steam engine, may delve with profit. It is a study, however, that is pursued with difficulty save by the aid of a working model on which the many combinations of lap, lead, angular advance, point of cut-off, etc., one with the others and with the piston travel, can be easily effected and observed. The trouble with the conventional valve-motion model is that it is bulky, inconvenient to operate and costly if made to a scale that is of any practical use. A locomotive valve-motion model made half-size requires a floor space of, say 3 feet by 7 feet, and a helper is a quite necessary adjunct to turn the crank. As a brake is never supplied by which the unhappy seeker for knowledge can stop the too-willing crank twister short, the apparatus is usually more productive of profanity than anything else. For home study such an ungainly rig is out of the question, and even in the lodge room the space required is often a serious objection.

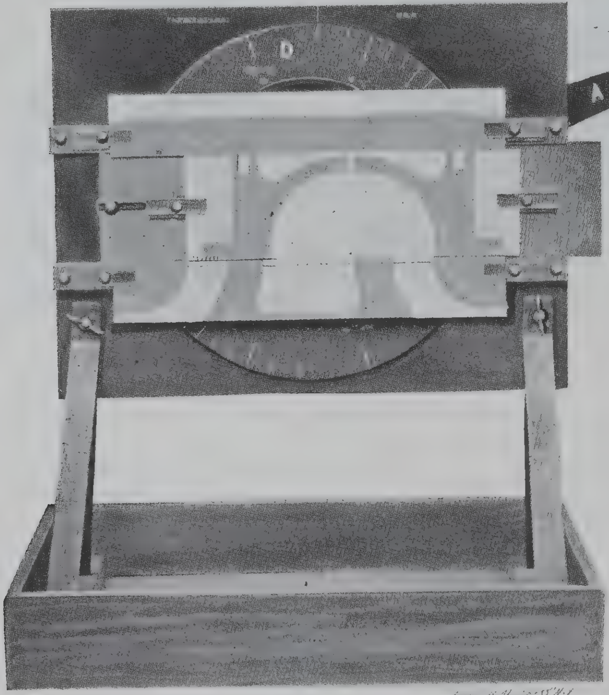


Fig. 5. Front View.

Colvin's Valve Motion Model.

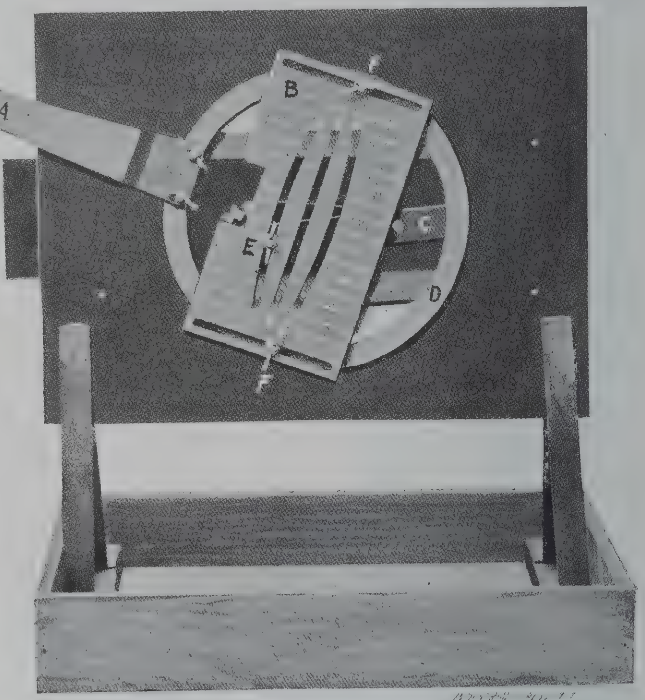


Fig. 6. Back View.

The accompanying illustrations show a valve-motion model patented by Henry F. Colvin, which is of very compact design. It reproduces the various events of steam engine slide valves of different constructions, especially of locomotives, to full scale save one, the Vauclain piston valve, which is shown one half size. It is made to fold up and go into a box 14 x 18 x 3 inches. The box forms the base when the machine is set up, and then the total height is 21 inches. The valves, the sections representing the ports and the balance plate, are printed on strips of heavy cardboard, which are held in place by buttons as shown in Fig. 5. This view shows a Richardson balanced valve for 5 inches travel. Three D-valves for 5, 6 and 7 inches travel; an Allen ported valve; two piston valves, one for outside and the other for inside admission; a Vauclain piston valve; a Wilson high-pressure multi-ported valve (eight in all); and the accompanying port sections for each valve, are furnished with the outfit. All the parts are assembled by thumbscrews so that no wrenches or other tools are required.

Fig. 6 shows the back of the model and gives a more adequate idea of the principle on which it operates. The handle *A* revolves a disk *D*, which is graduated on the face side to represent inches of piston travel, 24 inches stroke being taken as the base. When the zero mark corresponds to the datum line in Fig. 5, the crank is supposed to be on the center. Rectilinear motion is imparted to the valve by a peculiar combination of two connecting-rods, one of which shows at *C*. The other shows in Fig. 6 just above it through the slots in the plate *B*. This one is just one-half the length of *C*, center to center of the outer pin holes. One end is connected to the valve and the other to the center of *C*. Rod *C* is connected to the plate *B* at *E*, and the other end reciprocates in a short horizontal slot in the frame. Plate *B* turns with the disk *D* and, of course, the connecting-rod *C* being pivoted to it at *E*, a crank motion is imparted to it, which in turn is transmitted to the valve through the short link alluded to. The point of connection *E* can be changed along the curved slot, thus imitating the effect of the Stephenson link by increasing the lead as the link is hooked up for short cut-off. Or if located in the other curved slot, the effect of crossed eccentric rods is imitated, the lead decreasing as the cut-off is shortened. Constant lead at the various cut-offs can be effected by changing the thumb screw connection to the straight slot. Nominal lead is changed by loosening the thumb screws *F F* and shifting the slotted plate *B* relative to the disk *D*. This has the same effect as changing the angular advance, and is virtually the same thing. Further information may be obtained from the Derry-Collard Co., 256 Broadway, New York.

* * *

An electric switch is being tried in Pittsburg by which the motorman can control the direction his car will take at a junction, without stopping the car or removing his hands from the controlling levers. A section of the trolley wire approaching the switch, is separated from the main line and is independently charged. It is so connected that if the car takes current when passing over this section a powerful electro-magnet in the track will be energized and throw the switch point. If the car approaching the junction is to continue without throwing the switch point, the motorman must shut off the current before reaching the switch operating section and pass over it by the momentum of the car. The switch then remains unchanged.

* * *

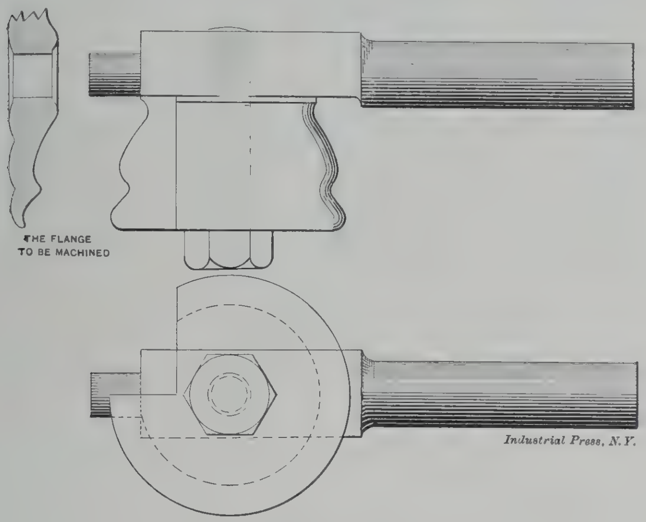
Descriptions of several interesting tools of original design have been contributed to our columns by Mr. Jos. M. Stabel. Mr. Stabel writes us that he has received several inquiries as to prices of these tools, etc., and wished to state that none of them are on sale and the ideas are simply contributed for the benefit of the readers of MACHINERY.

LETTERS UPON PRACTICAL SUBJECTS.

A FORMING TOOL FOR FINISHING FLANGES.

Editor MACHINERY:

For finishing the flanges of bath cocks it had always been customary for us to use four cutters in a holder and any toolmaker will appreciate the difficulty that we had to keep these cutters all of the same shape when they were ground. To obviate this trouble I designed the tool shown in the sketch, so that but a single cutter would be required. A round forming tool was made to correspond with the shape of the flange and this was fastened to a holder or shank, made from a piece of 1½-inch square steel. One end of this shank was turned down to fit the hole in the turret while the front end was turned to fit the hole in the flange and acted as a guide and support for the cutter. The cutter was clamped to the holder by a bolt with a left-hand thread, so that the tendency of the tool, when at work, was to tighten itself against the shank. With this tool we are able to do much more and better work than we could with the old holder having four cutters and the grinding is, of course, reduced to one-quarter of the amount. There are many jobs of turret work where a cutter and holder of this description can be used to a great advantage.



Flange Forming Tool.

M. SCHILLING.

St. Paul, Minn.

TESTING A LEADSCREW.

Editor MACHINERY:

In the May issue of MACHINERY, Mr. Stabel, in his article on micrometer measuring instruments, gives a method of testing the leadscrew of a lathe. He does this by chucking a micrometer screw so as to expose the threaded end and using an indicator held in the toolpost of the lathe, the point of the indicator bearing against the side of the thread, as shown in Fig. 5 of the sketches illustrating his article. I consider this method as being rather poor; first, because the leadscrew can be tested over a length of only about one inch, at a part determined by the location of the indicator with reference to the carriage; and secondly, because there are several chances for errors to creep in. To give satisfactory results the micrometer screw must not only be of the correct pitch but it must run perfectly true and be of uniform diameter. Otherwise the indicator will increase any existing error to such an extent that the results will be quite unreliable.

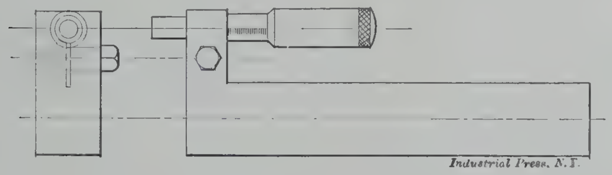


Fig. 1. Micrometer for Testing Leadscrew.

What I consider a much better way for testing the pitch of a leadscrew, at any position of its length, is to procure a micrometer screw and barrel complete, such as can be purchased from any of the manufacturers of accurate measuring instruments, and bore out a holder so that the axis of the micrometer screw will be parallel to its body when the screw is in place, as shown in Fig. 1. With the lathe geared for any selected pitch, the nut engaged with the leadscrew, and all backlash of screw, gears, etc., properly taken up, clamp the micrometer holder to the lathe bed, as shown in Fig. 2, so that the body of the holder is parallel to the carriage. Adjust the micrometer to one inch when the point of the screw bears against the carriage and with a surface gage scribe a line on the outer edge of the faceplate. Now rotate the lathe spindle any number of full revolutions that are required to cause the carriage to travel over the portion of the leadscrew that is being tested, bringing the line on the faceplate to the surface gage point. If the distance traveled by the carriage is not greater than one inch, the micrometer will indicate the error directly. For lengths of carriage travel greater than one inch an end measuring rod, set to the number of even inches required, can be used between the micrometer point and the lathe carriage. The error in the leadscrew is then easily determined by the adjustment that may be required to make a contact for the measuring points between the carriage and the micrometer screw. The pitch can be tested at as many points as are considered necessary by using end measuring rods, of lengths selected, set to good vernier calipers. The style of holder shown can, with the micrometer screw, be used for numerous other shop tests and as the screw is only held by friction caused by the clamping screw, it can easily be removed and placed in any form of holder that is found necessary.

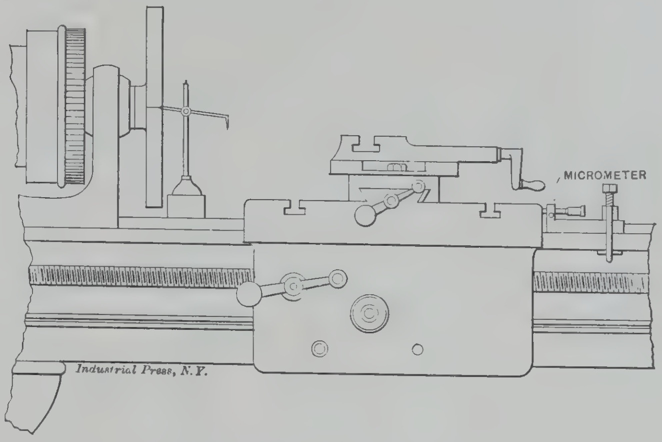


Fig. 2. Testing the Leadscrew.

CANTELO.

CORRECTION TO "PROPORTIONS OF GEARS."

Editor MACHINERY:

Referring to the article in your May number on "Proportions of Gears" by C. F. Blake, I desire to call attention to an error in his formulæ. In both the elliptical and T sections he substitutes,

$$R = \frac{n\,p}{2\,\pi} = .16\,n\,p$$

in which "n" is obviously the number of teeth, whereas he takes "n" to be the number of arms and uses this notation in his first formula,

$$M = \frac{W\,R}{n}$$

He should have substituted

$$R = .16\,N\,p$$

where "N" is the number of teeth. This reduces the final equations to the following:

$$\text{Elliptical section } h = \sqrt{2.7\,\frac{f\,y\,p\,N}{n}}$$

$$\text{T-section } h = \sqrt{1.6\,\frac{f\,y\,p\,N}{n}}$$

In the T section formula the constant 1.6 is correct, the decimal point having been wrongly placed in the original print, so as to read .016.

Mr. Blake's original formula gives the same value of "h" for all diameters of wheel and for all numbers of arms, which is obviously incorrect.

Using oval arms the somewhat general practice in the Pittsburg District is to make the thickness of arm $b = \frac{1}{2}h$, instead of making it depend directly on the pitch, as this gives a thicker arm and more lateral strength, the casting having been found to be readily made and not unduly strained.

Taking the same notation as Mr. Blake, which is as follows:

h = width of arm at center of wheel.
p = circular pitch.
f = face.
R = radius of gear.
y = constant as per table, usually about 1-10.
n = number of arms.
b = thickness of arm at center of wheel.

We may write:

$$h = \sqrt[3]{\frac{20\,p\,f\,y\,R}{n}}$$

and $b = \frac{1}{2}h$, which give very good results over a wide range.

There is a "Rule of Thumb" which makes the width of arm just under the rim equal to $2 \times p$ tapering ¾-inch per foot, the thickness being $1 \times p$ tapering ⅜-inch per foot, which on careful consideration proves to be pretty well founded and to agree with the theoretical values fairly well.

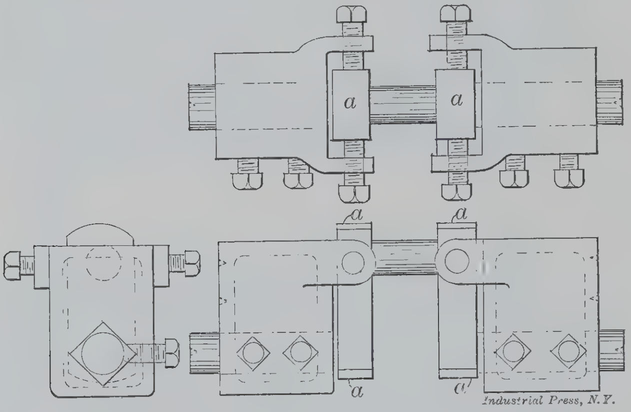


Fig. 1. Dogs for Holding Crank Shafts.

If we assume that in ordinary practice the following values are seldom exceeded:

$f = 4\,p$.
y = constant, say 1-10.
$n = 6$.
$R = 20\,p$, equivalent to gear of 126 teeth.

We can write,

$$h = \sqrt[3]{\frac{20\,p \times 4\,p \times 20\,p}{10 \times 6}}$$

$$h = \sqrt[3]{26\ 6\,p^3} \text{ or nearly } h = 3\,p$$

Now, our "Rule of Thumb" will evidently come pretty close to this as the taper will in some measure allow for the large diameters and to show how near it will come, I have prepared the following approximate table in which $p = 2''$, y = 1-10, and $n = 6$.

		$h = \sqrt{\frac{20\,p\,f\,y\,R}{n}}$		h by Rule of Thumb
No. of Teeth.	Radius.	$f = 6''$	$f = 8''$	$h = 2\,p + \frac{R}{16}$
30	9.5	3.5	3.7	4.5
50	15.9	4.0	4.4	4.9
70	22.3	4.5	5.1	5.4
90	28.6	4.9	5.4	5.8
110	35.0	5.2	5.7	6.2

From this table it is evident that the simple rule is practically correct and its simplicity recommends it in place of more elaborate formulas even though it will come somewhat heavy when narrow faces are used. In the smaller diameters the number of arms will usually be less than 6, which will make the agreement still better.

The above data was developed some years ago when the writer was looking into the matter of gear proportion, and is written in the hope that it may prove of some value to any of the readers of MACHINERY who may be engaged in work calling for the designs of well proportioned gears.

F. C. BIGGERT, JR.

TOOL FOR TURNING CRANK SHAFTS.

Editor MACHINERY:

The tools and methods here described have been employed at the Western Iron Works, Los Angeles, for the past three years, during which time many more gas engine cranks have been turned out than could possibly have been produced with the same lathes using ordinary methods. Fig. 1 shows the jigs or dogs which are used to secure the cranks on centers. No great exertion is required to secure the crank in these jaws, yet once secured, there is no possibility of its slipping as the grip is positive and sure. Each dog consists of a hollow box casting in each end of which is cored a square hole through which the shaft is passed. This hole is placed diagonally with the line of shaft centers in order that a difference in the diameter of the shaft will not change the stroke of the crank. Of course in the same shaft both ends would be of the same diameter but this might vary in different shafts by a quarter of an inch, more or less, and yet have no effect on the stroke of the crank nor cause any difficulty in holding the work in the dog.

The first operation is to slip the dogs onto the ends of the crank and tighten the setscrews lightly on the shaft. Then adjust the screws in the ears, by eye, and put the work on the lathe centers. Now, with the inside calipers, test the ends of the shaft by the lathe shears with the shaft and crank pin centers about on a level. This done, and the dogs properly adjusted, the shaft is ready for turning and with a good tool of self-hardening steel an opportunity is afforded for making a record in stock removing, for the jigs will stand any strain within the power of an ordinary engine lathe. When enough stock has been removed from the square rough forging to make the pin nearly circular, a larger flat will be found on one side than on the other. To the experienced eye this indicates that the stock was not properly divided and it is now in order to loosen the setscrews, in the ears, on the side of the large flat and tighten those in the opposite ears. Once more test the ends of the shaft by the lathe shears and proceed to finish turning the crank. The writer has also tried the use of the surface gage and face plate process for adjusting the stock exactly central in the first place, but experience has shown the method above outlined to be preferable because of its economy of time and greater degree of certainty.

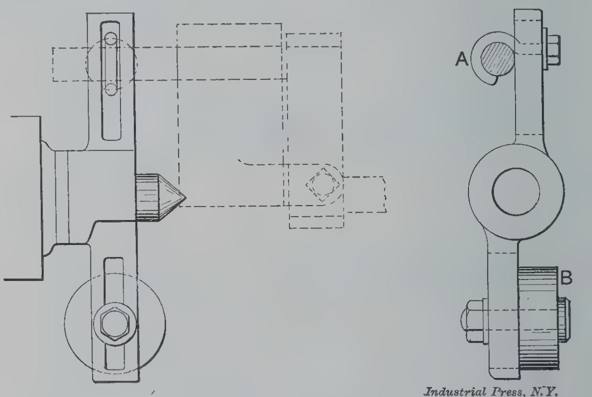
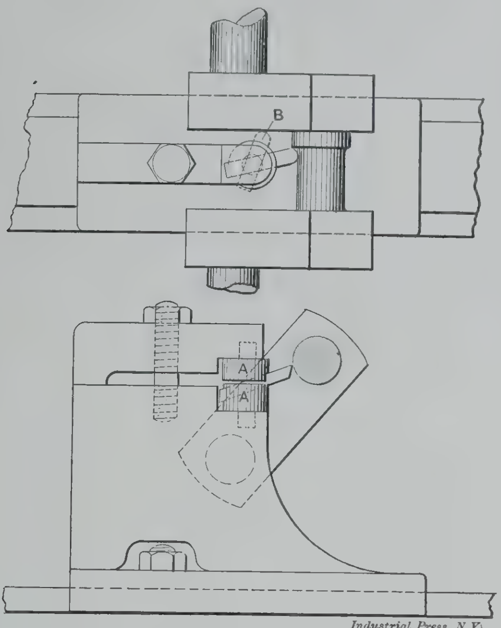


Fig. 2. Method of Driving Crank Shafts.

In making these dogs a mid-center is placed between the pin and shaft centers to permit turning the ends of the crank cheeks, a, a, Fig. 1. Besides making a better looking crank, the saving of time in using a mid-center is fourfold over the usual practice of turning off the ends on the shaft and crank centers, respectively. In the first place, by swinging on mid-centers the cutting diameter is reduced to one-half, thus admitting of double the speed of the lathe, while by cutting both faces at one time another reduction of fifty per cent. is obtained.

For a driver for the cranks the writer devised the arrangement shows in Fig. 2. This screws onto the lathe spindle in place of a chuck, the object being to shorten the distance between centers, thereby stiffening the work. A hook bolt *A* secures the end of the shaft to the driver while on the other end of the driver is mounted the counterweight *B*.

Fig. 3 shows a special tool rest which takes the place of the usual long slender tool that reaches in between the cheeks of the crank. With this rest we get right up to the work with a piece of self-hardening steel 3/8 inch square and but about 2½ inches long. The thickness of this rest as made for a 36-inch lathe is 1½ inches, and the little collars *A*, *A*, are 1⅝ inches in diameter. They are slotted at an angle so as to secure rake to the tool without resorting to top grinding. Each collar has a teat to hold it central in position, the teats fitting holes in rest and clamp. The dotted lines at *B* show how the tool may be turned to work at any angle, at the same time retaining its top rake.



Industrial Press, N.Y.

Fig. 3. Tool Rest for Turning Crank Shafts.

S. Byron Welcome.

Los Angeles, Cal.

GOOD AND POOR MANAGEMENT.

Editor Machinery:

During my travels I have come across many cases of good and poor management. I remember one foreman who used to be always rushing about the shop, and if anyone asked him a question he would hardly take time to answer but he would rush away, maybe to go and "row" a man for some small mistake, or perhaps nothing at all. He was always so busy he never had time to plan the best way to get things done; I don't believe he ever thought about it at all. When anything was wanted he would give it to a machinist with instructions to do it as fast as possible, any way so long as it would "go" when done. He would give a man a job and a few hours later tell him to leave it and do another, and perhaps in a short time he would give him a rush job. Every man in the shop had about fifteen different jobs in hand, most of them about half finished; the shop was piled up with work, some of it just started, the greater part half-done, and there were signs of great activity among the workmen, most of whom were using a hammer and chisel, or dragging heavy castings around and making plenty of row, for the workman who wasn't making a big noise and scurrying around, wasn't working. Yet for all this the output of the shop was low, very low, and the office used to complain. This worried the foreman and he would go around and raise Cain till everything was in a whirl. Still things got worse, so he was finally discharged; he left saying: "I do not care who comes, they cannot make the men work any harder," and I guess he was right.

The next foreman did not try to make them work *harder*, all he got them to do was to work *faster*. In a short time one would hardly have recognized the shop; there was no excitement, the men were not running about, there was much less noise, the hammer and chisel were used less. A machinist was given some work to do with a general outline of how it was to be done, and it had to be done right; only very urgent jobs were allowed to disturb the systematic running of the shop, the men were not "rowed" at regular intervals to keep them going, and the output of the shop was high. This shows one of the mistakes a foreman often makes: he thinks he must keep everyone on the jump, and imagines that the more he can scare a man the more work he will do. This mistake is made by many superintendents also; they go around two or three times a day and jack up the foremen, telling them they do not get enough work done, don't know how to manage a shop, and leave in a huge temper; the foreman generally feels disgusted with the whole business and will not take any interest in it at all, or else gets scared and tries to make things hum. Anyhow both ways are failures.

I once knew a superintendent who would not order any stocks and dies for the machine shop. He said: "Manage without." He was trying to keep costs down, and everything that required a thread had to be cut in a lathe. In another shop, when a machine broke down, the superintendent said: "Just fix it temporarily, any old way so that it will run." He would not order new parts, and so kept repair costs down for over a year. By this time most of the machinery was in a patched-up condition, breakdowns began to be very frequent and this meant delays. As the expense of duplicate parts had been saved, the temporarily patched-up machines would not last long, and it became necessary to temporarily repair the temporary repairs. The breakdowns caused a considerable fall in the output, yet the machinists were working overtime, the cost of repairs was rising by jumps, and looked even worse because of the very low repair costs the previous year. The superintendent was consulted and these facts were pointed out with painful accuracy, and he was asked to explain why. When the cause was explained, his high reputation for economic work fell below par.

There was the manager at a place where there was no time system. The men used to come and go as they pleased and book their time in the way which suited them best. This kind of work showed up in the profit and loss accounts, especially in the loss column, so the manager planned and got up a first-class time system. The men did not approve of this, as they liked the other way best, and a letter threatening strike was sent to the president; he was scared, and let them have their own way, and the time system was dumped. Afterwards the president used to wonder why the superintendent had such poor control over the men.

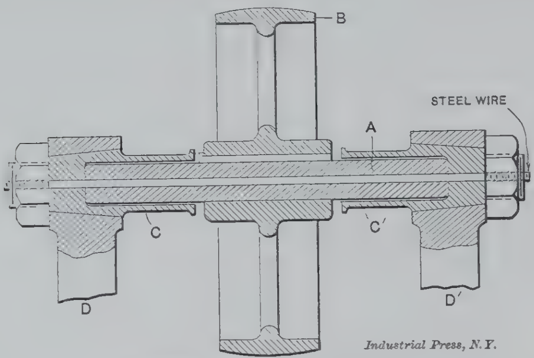
Philadelphia, Pa. Geo. P. Pearce.

CRITICISM OF THE GERMAN ANTI-FRICTION BEARING.

Editor Machinery:

In the February issue of Machinery there appeared an illustration and description of a new "anti-friction" bearing of German design. Ever since the appearance of this article I have been expecting to see some comment on the arrrangement, and not having seen anything, I will ask to be allowed a little space in which to discuss this bearing, possibly to the benefit of some one who, attracted by the claims, might be tempted to make use of it for work to which it is in no way suited. The statement made in this article that "the smaller the diameter the less the frictional resistance to rotation," is somewhat misleading and should have been modified by adding "provided there is still sufficient bearing area to allow of proper lubrication." Frequently bearings of large diameter will run with less frictional resistance than smaller ones in which the bearing area is so limited that the oil is pressed out and a metal-to-metal contact results.

Now there is very little reason for thinking that the bearing in question is perceptibly better than a good steel pivot bearing. That the wire must be cut by shearing is *not* due to the tension, for the hub of the pulley is a good fit between the supports for the wire, and nothing but shearing action could be produced, tension or no tension. The principal ground for criticism in this device is, I think, the claim that ample bearing surface is provided by the length of the wire. A little thought will show, however, that this is not so since the amount of bearing surface is practically independent of the length of the wire. Considering the case illustrated, where we have a 200 pound pulley running on a wire .016 inches in diameter. Imagine, if you can, a wire less than one-half of the size of a No. 60 drill supporting a 200-pound pulley; and also imagine that this weight is distributed equally over the whole length of the wire. It seems much more natural to suppose that as the pulley is run its hole will wear larger at the end and the wire will wear smaller where it emerges from its supports until it finally breaks under the shearing stress, while the greater part of its length will not be worn perceptibly. On examining the sketch it will not require very deep thinking to see that not only does the central portion of the wire fail to help support the pulley, but, on the contrary, it will bear on the wall of the hole opposite to the side upon which the power is applied.



German Anti-friction Bearing.

That the pulley runs easily there can be no doubt, but that does not prove that this is a practical device. Lubrication would be practically out of the question, a few simple figures showing that the pressure per square inch would be too high. I do not know how easily our German friends are aggravated but on this side of the "Pond" we would hardly consider it profitable to be obliged to have a coil of wire handy and to supply a new bearing at frequent intervals simply to eliminate a little friction. CORNEIL RIDDERHOFF.

Grand Rapids, Mich.

[For the purpose of making the above contribution more readily understood we have reproduced the illustration that was published, with the description of the bearing, in the February issue.—EDITOR.]

THE CONSTRUCTION OF A SUB-PRESS DIE.

Editor MACHINERY:

Owing to the large number of parts of which a sub-press die is composed its first cost is, of necessity, much higher than that of an ordinary die. When, however, we consider that a sub-die, when properly made, will run ten hours per day for weeks at a time, without grinding, the first cost sinks to a minimum. In using an ordinary double die it is absolutely impossible to obtain two blanks that are exactly alike, one reason being that the stock to be punched is more or less wrinkled and does not lie flat on the face of the die. The consequence is, therefore, that after the piercing punches have perforated the wrinkled stock, and it is then flattened out, there is a greater distance between the holes than there is between the punches. Also, the pilot pins that are depended upon to locate the stock cannot do so exactly since they are made a trifle smaller than the piercing punches in order to prevent them from pulling the blank up out of the die. On a certain class of work the double die answers all purposes, but when accuracy is required a sub-die is the only one that will give satisfaction.

In order to avoid a complicated drawing and to set forth the plans of a die that may be readily understood by those not familiar with sub-dies, the writer has selected for illustration the die used for punching an ordinary washer; the general principles of sub-dies being the same whether one or one hundred punches are employed. Having selected a frame with its proper cap, of size suitable to the work, it is placed in a chuck, being held by the upper end and, having faced off the bottom, the recess at *A A* is bored to fit snugly the corresponding step on the base of the press. This base is finished on both top and bottom with a step above referred to turned to fit in the bottom of the frame. A slot at *G* is cut in each end to receive the finger straps by means of which the frame is fastened to the faceplate. The center is recessed to receive the stripper plate and blanking punch and a hole is drilled completely through to allow scrap punchings to fall to the floor. The base and frame are then fastened together by means of tap bolts and dowel pins as shown in the sectional view of the press. Together they are clamped to the faceplate, being centrally located by means of a plug center which fits the taper of the lathe spindle and passes through the hole in the center of the base. In this position the frame is bored out to a taper of about one-half inch per foot. After boring, a splining tool is substituted for the boring tool and, with the lathe locked by means of the back gears, three or four grooves, *B*, *B*, are cut the entire length of the bore by sliding the carriage back and forth. At the same setting the upper side of the frame is faced off and threaded to receive the cap which is screwed on the frame, then the hole for the plunger is bored out to the required size. This insures the hole in the cap being central with the inside of the frame.

The plunger, shown in detail in Fig. 2, is the next piece to receive consideration. After being centered and rough turned, it is put in the center rest and the hole *C* bored and threaded and fitted with the button shown in Fig. 3. This threading is carried down to quite a depth in order to allow of the insertion of a tension cap, Fig. 4, by means of which a sufficient tension is placed upon the stripper spring to force the punching back into the stock upon the return stroke of the press. A dog is fastened to the button and the plunger turned to fit the hole in the cap, great care being exercised to keep the sides perfectly parallel. After turning, the lathe is blocked by the back gear, and three grooves *E*, *E*, *E*, are splined, about 1-16-inch deep, for the entire length. It is essential that these grooves be parallel with the axis of the plunger. Before the plunger is completed a ring three-quarter inch wide, is made of machine steel and forced onto the lower end of it. The outside of this ring is trued up, using the plunger as an arbor, after which this end of the plunger is placed in the center rest where the ring prevents it from being scored or injured by the center rest. In this position the recess seat *F* is bored out to receive the punch holder shown in Fig. 5.

The punch holder is made, as are also the die stripper and punch, Figs. 6 and 7, by turning from a bar held in the chuck and finishing complete before cutting off. The recess which receives the head of the piercing punch should be bored at the same time to insure its being central with the tool-holder. The stripper, Fig. 6, should be made of tool steel and left large to allow for grinding after hardening, while the hole is bored sufficiently small to allow for lapping to exact size. The blanking punch, Fig. 8, which also contains the piercing die, is made of tool steel in the same manner, being finished complete before it is cut off and it is left with sufficient stock to grind after it has been hardened. The holes *H H* are drilled and counterbored for screws to hold the punch to the base.

After the parts are hardened the blanking die is the first to be ground. It is gripped in a chuck, bottom end outward, and the large hole *J* is ground out to fit the step *K* on the punch holder. Then the hole *L* is ground perfectly straight and of the same diameter as the master templet. The bottom is also ground off, thus completing the die. In the stripper the hole *M* is lapped to the same dimension as the master templet. A round piece of cold rolled steel is gripped in a lathe chuck and turned to fit nicely this hole in the stripper. Without disturbing the chuck, wring the stripper onto this arbor and grind the flange or shoulder *N* to fit nicely the larger bore, and the smaller diameter to fit the smaller bore, of the die. The blanking punch is finished in exactly the same manner as the stripper, being ground to fit the recessed seat in the base. The minor parts such as the stripping plate, stripper piston, pins and springs are then made and the press is ready to assemble.

In assembling, first force the punch holder, Fig. 5, into the seat *F* of the plunger and then force the die onto the holder; transfer the holes in the die through the holder and into the plunger and after they are drilled and tapped, fasten the parts together as shown in the sectional view. Remove die and drill four holes in the punch holder and plunger for the stripper pins *O O*. Place the stripper piston in the plunger, above this the spring, and lastly screw the tension cap into place. The stripper pins *O O*, which are hardened for their entire length, are placed in their holes in the punch holder and the stripper placed in the die, which is then secured in its place on the punch holder.

The blanking punch is placed in its seat in the base and securely fastened by the cap screws, after which the springs are placed in position and the stripper plate drawn down, by means of the screws *P P*, until it is a trifle below the top of the blanking punch. When the die is fastened to the frame it is ready to be babbitted. Screw the button onto the plunger and with a piece of oily cloth wipe the plunger all over, then sprinkle flake graphite onto it. The oil on the plunger will cause the graphite to adhere and after the surplus has been blown away a thin coating will be left over the entire surface. The plunger is lowered inside of the frame until the blanking punch enters the die. In the cap insert the ring shown in Fig. 9, to prevent babbitt from flowing into the recess *R*, and screw the cap onto the frame. As the cap is an exact fit for the plunger it therefore aligns it with the frame and with the blanking punch. The grooves on the plunger must be plugged with putty where they pass through the cap in order to prevent the escape of the babbitt while pouring. A pair of parallels, of a height equal to the projection of the button beyond the top of the cap, are now placed on the bench and the die inverted upon them. Great care should be taken to avoid any vibration during pouring as very little will affect the alignment of the plunger, so that it is better to do the babbitting at the noon hour or at such other times that the power is not running. Before pouring, heat the frame with a torch or jet of gas and when the babbitt has attained the proper heat, which is a very dark red, pour it in from both sides of the die simultaneously. Allow it to remain until thoroughly cool, then remove the plunger, strap the frame to the faceplate of a lathe and cut a spiral oil groove the entire length of the babbitt.

As the blanking punch has already been ground the next step is to grind the faces of the blanking die, piercing punch, and stripper, while all are in their proper positions in the plunger. They should be ground so that the face of the stripper, die, and punch are all flush with each other. After grinding, the parts should be taken from the plunger and thoroughly cleaned so that no emery can possibly remain in the working parts. Oil all of the running parts in a thorough manner, then put them together in their proper positions and replace the plunger in the frame. In setting up a sub-die care should be taken to have the punch come to the face of the die only and not enter it.

Frank E. Shailor.

New Haven, Conn.

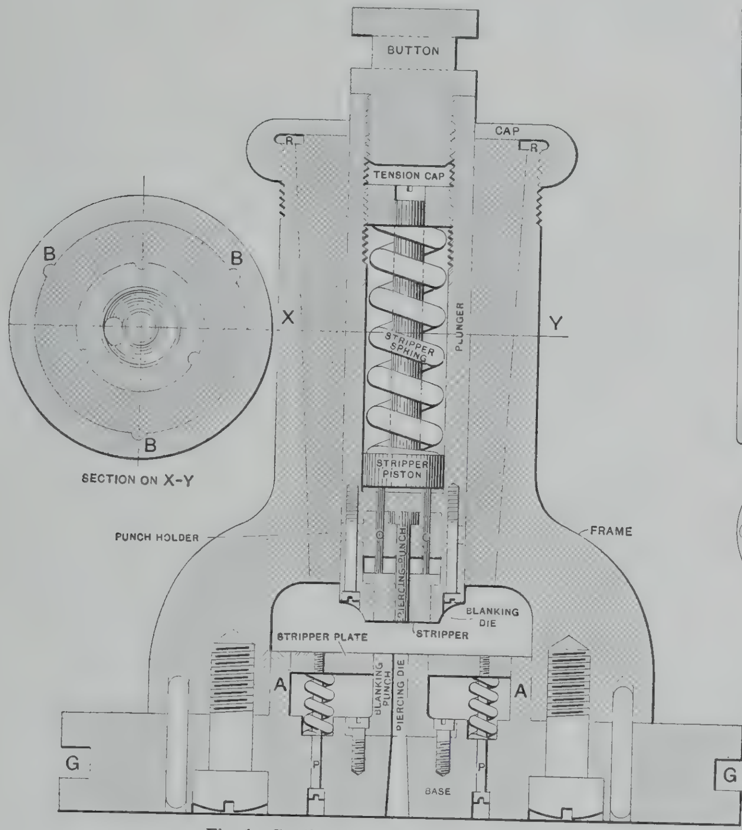
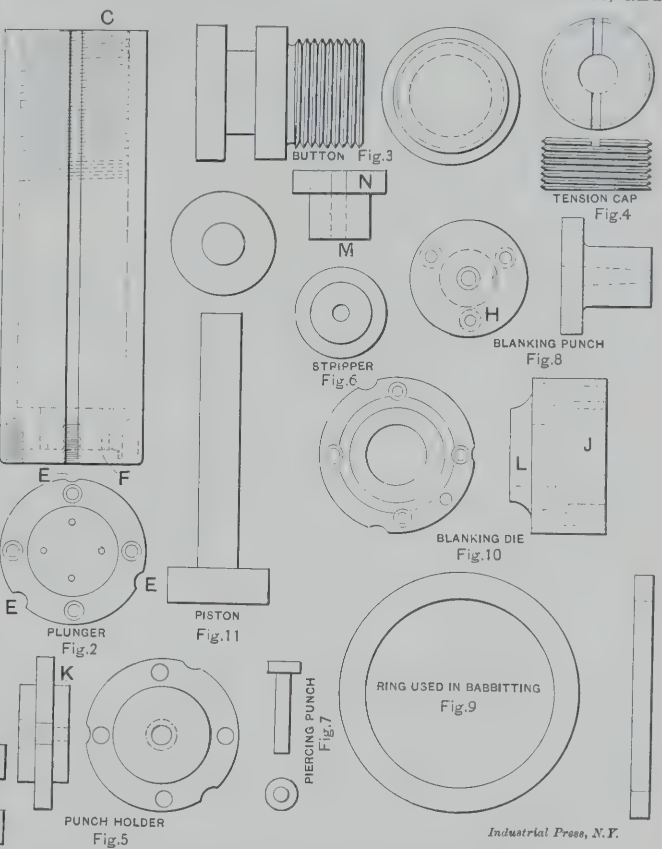


Fig. 1. Section through Sub-Press.



Details of Parts Composing Sub-Press.

* * *

A writer in *Dixie* imparts some interesting information regarding the combustion of certain compounds. It is the common practice of engineers to estimate the calorific value of a fuel from its chemical composition, and, generally speaking, the figures so obtained are accurate. There are exceptions, however, where this method will not give correct results, and acetylene is one of them. Certain foodstuffs, as starch and sugar, show the same peculiarity, their heat of combustion differing widely from that estimated from their chemical composition. The chemical composition of acetylene is given by the formula C_2H_2, so that 13 pounds of the gas consists of 12 pounds of carbon and 1 pound of hydrogen. The perfect combustion of 12 pounds of carbon to carbonic dioxide will give 174,000 heat units, and 1 pound of hydrogen burned to H_2O will liberate 62,000 heat units, making a total of 236,000 heat units. Actual measurement, however, shows that the heat set free by the combustion of acetylene, is 281,250 units, or nearly one-fifth more than would be calculated from its composition. The heat of combustion of cyanogen (C_2N_2) is nearly one-third more than that calculated from its carbon contents. The explanation for this discrepancy is found, of course, in the fact that a large quantity of energy is absorbed in the formation of these compounds which is liberated in the form of heat on burning them. It is this fact that gives acetylene an element of danger as an explosive; for, apart from any question of combustion, there is a large store of energy available for destructive purposes by the mere decomposition of the gas into its elements.

THE THEORY AND APPLICATION OF THE PRINCIPLES OF ISOMETRIC DRAWING.

A. B. BABBITT.

This article is written to give both the theory and practical application of isometric drawing. To those who have a knowledge of orthographic projection, the theoretical portion may be of value, while all engaged in mechanical drawing should derive some benefit from the practical treatise of the subject.

Theory.

Let us imagine a cube with its bases parallel to a horizontal plane and its lateral faces making angles of 45 deg. with a vertical plane. Three views of this cube, top, front and side, are shown in Fig. 1. Draw AB the diagonal of the cube. Revolve the side view until the diagonal AB is horizontal, as shown in Fig. 2, and obtain the front view which will be the isometric drawing of the cube.

By studying this view carefully, it will be noticed that all lines of the cube are either vertical or 30-deg. lines and that the foreshortening of these lines is exactly the same in each case. The ratio of lengths of lines in the isometric to those in the orthographic drawing may be found in the following manner:

In the top view of Fig. 1, we have the edges of the cube shown in their true lengths, while in the front view, Fig. 2, the edges are shown in their isometric lengths. In the top view, Fig. 1, the true length is shown on a 45 deg. line, while in the front view, Fig. 2, the isometric length is given on a 30-deg. line, the difference between the two angles being 15 deg.

It is perfectly obvious, then, that if we construct a triangle having the sides equal in length to the lines of the views already referred to and the included angle 15 deg., we may very easily find the ratio of one to the other. See Fig. 3. By laying off a standard scale on AB, the isometric scale may be obtained by drawing parallels to BC as shown in Fig. 4.

Practical Application.

Rules.

1. The lines shown in Fig. 5 are called isometric axes. They consist of a vertical line and two lines at 120 deg. with the vertical, drawn to the right and left from one common point.
2. These lines or axes represent lines mutually perpendicular, as the corner of the cube shown in Fig. 2.
3. All measurements must be laid off full size on or parallel to these axes.
4. All vertical lines of the object will be vertical in the drawing and all horizontal lines of the object will be 30 deg. lines on the drawing.
5. Lines parallel in the object will be parallel in the drawing.
6. Right angles on the object are usually represented by either 60 deg. or 120 deg. on the drawing.

To apply these principles to the drawing of a rectangular prism, proceed as follows: Use the line MO shown in Fig. 6 as a vertical edge of the prism and let this coincide with the vertical isometric axis. See Fig. 7. The line MS, a horizontal line of the object will be represented by a 30-deg. line drawn from M' to the right a distance equal to the length of the line MS, Fig. 6, and shown at $M'S'$, Fig. 7. The line, LM, Fig. 6, will be shown at $L'M'$, Fig. 7, drawn to the left from M' a distance equal to LM, Fig. 6. We now have the lines $M'O'$, $M'S'$ and $M'L'$ coincident with the axes shown in Fig. 5 and representing lines mutually perpendicular.

To complete the surface $LMNO$, draw (Rule 5) $N'O'$ parallel to $L'M'$ and $L'N'$ parallel to $M'O'$. To complete the surface $MSOP$, draw (Rule 5) $O'P'$ parallel to $M'S'$ and $S'P'$ parallel to $M'O'$. To complete the upper surface of the prism, $S'X$ must be drawn parallel to $M'L'$ and $L'X$ parallel to $M'S'$. To complete the prism and show all invisible edges, XY, YP' and YN' should be drawn parallel, respectively, to $S'P'$, $S'X$ and $L'X$.

If we make all lines of this isometric full size, as called for in Rule 3, the drawing will appear considerably larger than the object. To avoid this, an "isometric scale" may be made by using the method shown in Fig. 4. This will make the drawing appear nearer the size of the object.

Drawing Irregular Outlines.

To make the isometric drawing of the irregular solid shown in Fig. 8, proceed as follows: It is necessary to remember that measurements can only be made on or parallel to the isometric axes, and that these axes represent lines mutually perpendicular. To draw the oblique lines HG and KG in isometric, it will be necessary to determine the points H, G and K by means of measurements parallel to the isometric axes.

Produce the line KL to P and line HF to P and make the isometric drawing of the rectangular prism having one face $LPFE$. Such a prism is shown in Fig. 9. Measure off on PL the distance KL, giving the location of the point K. Lay off on FP the distance FH, giving the location of the point H. To obtain point G, lay off from P the distance PS, Fig. 9, equal to PS, Fig. 8, and draw SG parallel to PK. Make the distance SG, Fig. 9, equal to SG, Fig. 8. Having given the point G, HG and KG may be drawn and the irregular solid completed by drawing GG' parallel to HH' and $H'G'$ and $G'K'$ parallel, respectively, to HG and GK.

The method of finding the vertex of a pyramid is shown very clearly in Fig. 10. The points of the hexagonal base were obtained from the construction lines shown. Dotted lines and letters correspond in Figs. 10 and 11. The vertex is found by finding the center of the base by diagonals and measuring the altitude on a vertical line drawn from this point.

The Isometric Circle.

To draw the isometric circle, first draw the isometric of a square of a diameter equal to the diameter of the circle. Shown at $ABCD$, Fig. 12. Draw AC and bisect the sides of the square by means of diameter ef and gh drawn through the center. Draw Dg and Df. With B and D as centers and with a radius equal to Dg, draw arcs 1 and 2. With m and n as centers and with a radius equal to mf, draw arcs 3 and 4, thus completing the isometric circle.

The application of the isometric circle to the drawing of cylinders and cones is illustrated in Figs. 13 and 14.

* * *

THE NEW EXPLOSIVE, "HATHAMITE."

The danger attendant upon the use of dynamite is too well known to require comment, and because of this imminent danger not only to the users but the general public the invention of safe high explosives that will do the work of dynamite should be of general interest. Several high explosives have been heralded that are claimed to be much safer than dynamite and among them is "hathamite," the invention of the late George M. Hathaway, Wellsboro, Pa. A final test was made of "hathamite" at Wellsboro, May 2 (three days after Mr. Hathaway's death) in the presence of a number of capitalists and experts, with results that are reported to be very satisfactory and little less than wonderful. When properly detonated the compound explodes with terrific violence, having all the characteristic effects of dynamite. A piece of steel boiler plate 9-32 inch thick was laid on a steel block having a 2-inch hole. Two ounces of "hathamite" were exploded on top of the boiler plate over the hole in the block, and a 2-inch hole was found punched cleanly in the plate. Then a quantity was melted over an oil stove and poured like molasses into shallow tin boxes. When it hardened one of these boxes was set up as a target and a steel rifle ball shot through it without exploding the contents of the box. Then the remains of the cast explosive were taken into a mortar and pulverized with a pestle and after being subjected to hammering and grinding, the powder secured from this was again placed on a steel boiler plate and a hole punched through it, as before, showing that the quality of the compound had not suffered by melting, casting and again being reduced to powder, besides demonstrating its safety. One-pound, three-pound and six-pound steel shells were filled with the explosive and exploded in a large steel chamber producing wonderful fragmentation. Beside some of the shells exploded in the steel chamber were placed other loaded shells which did not explode from the violent concussion given them. The only way it can be exploded is by means of a detonating cap giving flame and concussion at the same time.

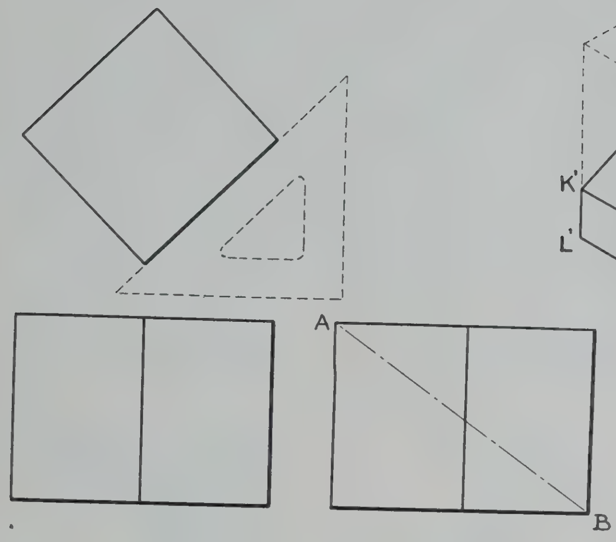


FIG. 1.

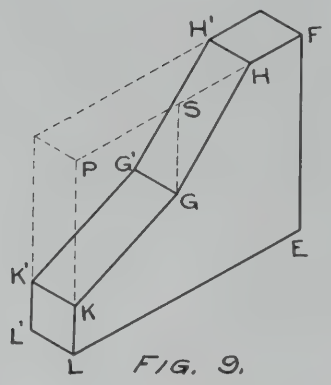


FIG. 9.

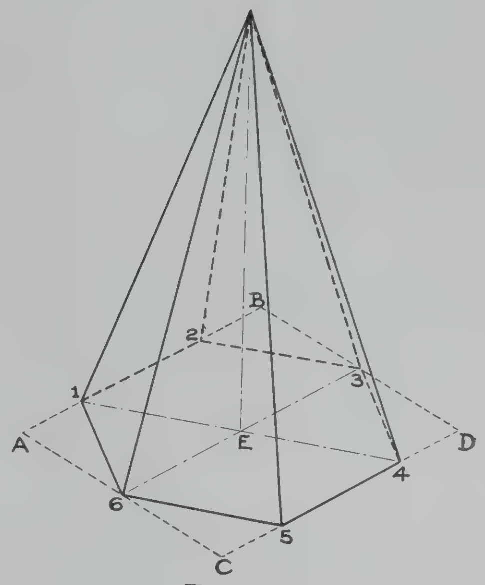


FIG. 10.

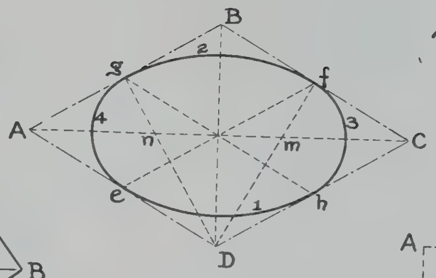


FIG. 12.

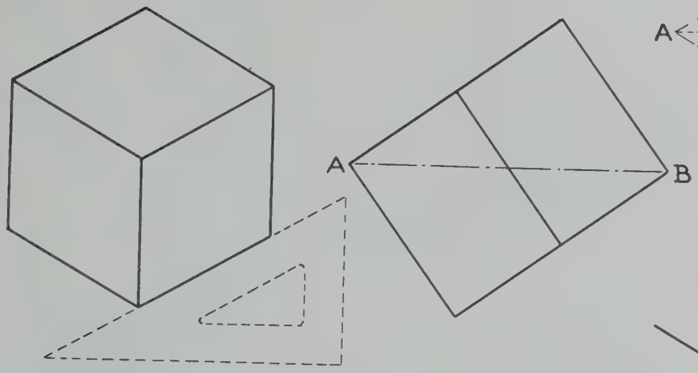


FIG. 2.

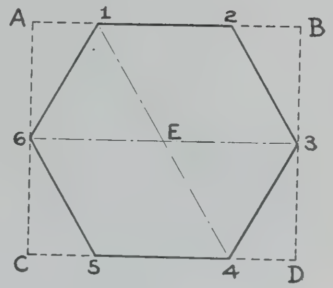


FIG. 11.

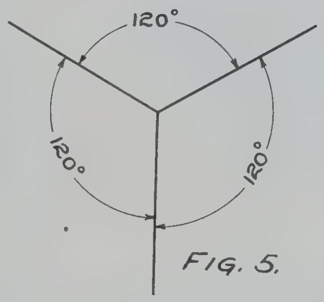


FIG. 5.

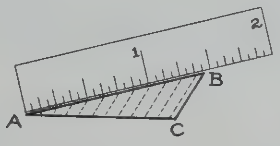


FIG. 4.

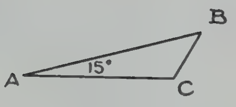


FIG. 3.

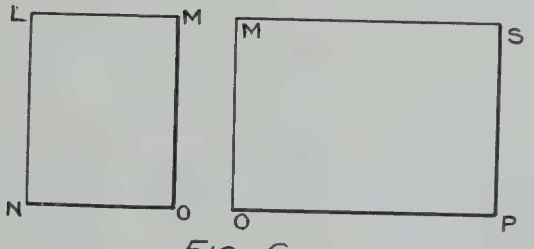


FIG. 6.

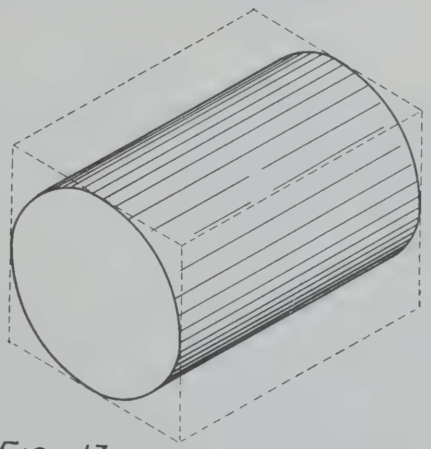


FIG. 13.

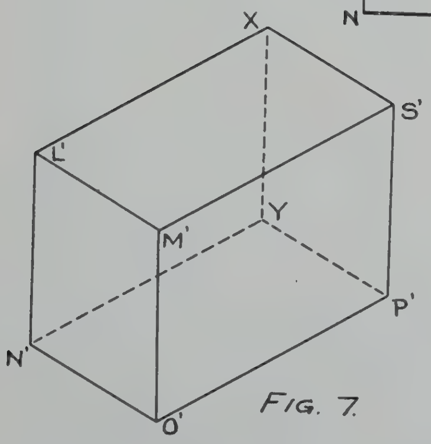


FIG. 7.

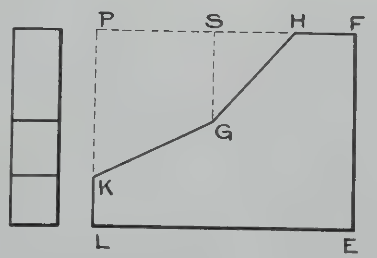


FIG. 8.

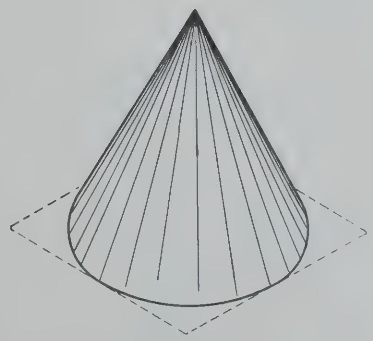


FIG. 14.

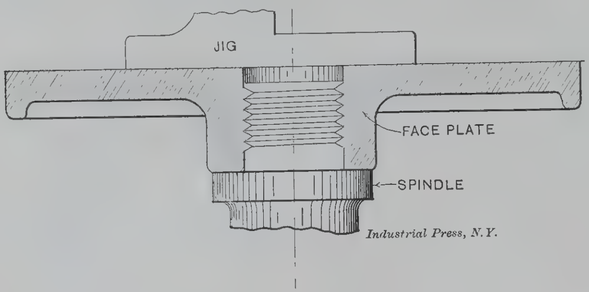
INDUSTRIAL PRESS, N.Y.

APPLICATIONS OF THE PRINCIPLES OF ISOMETRIC DRAWING.

CONTRIBUTED NOTES AND SHOP KINKS.

LOCATING JIGS ON THE FACEPLATE.

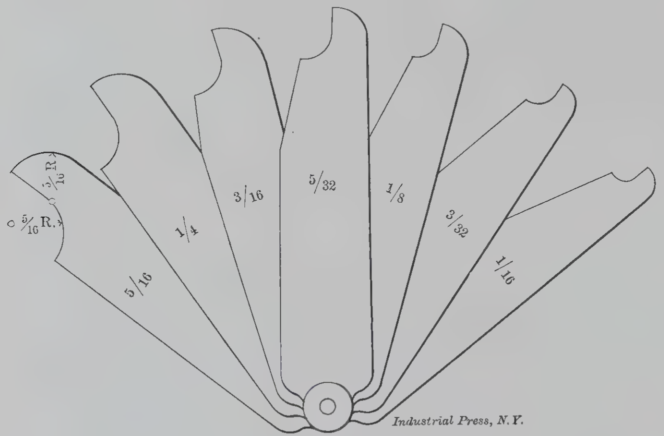
Commenting on a recent kink by George Henry, in which he advocates recessing the faceplate for locating jigs in the lathe, Francis Shaw writes: A simpler way is to turn out the first few threads in the faceplate hole, as shown in the sketch. This will in no way mar the plate and will accomplish the accurate location of the jig in exactly the same manner as described by Mr. Henry.



Industrial Press, N.Y.

A RADIUS GAGE.

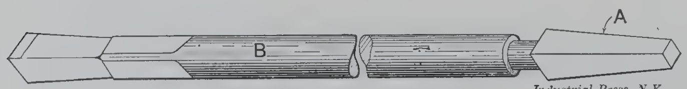
A. Putnam sends the sketch of a home-made radius gage which has proved to be very handy for all such work as rounding corners or grinding tools to a given radius. The blades are of thin steel and are fastened together at the end by a rivet, thus forming a tool similar to the familiar screw pitch gage. The right-hand corner of each blade is rounded off to the given radius, while the left-hand corner is cut away at the same radius, thus fitting the instrument to be used for either convex or concave surfaces. The radius to which each blade is shaped is plainly stamped upon the side.



Industrial Press, N.Y.

AN IMPROMPTU EXTENSION DRILL.

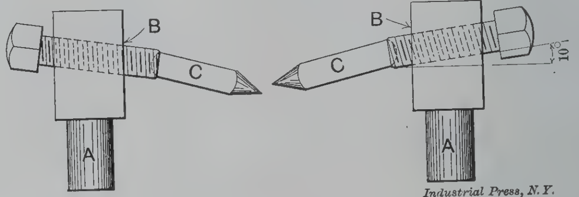
It often happens that it is desired to drill a hole or holes in a place which the ordinary length of twist drill with either a round or square bit stock shank will not reach; it then becomes necessary either to forge out a special flat drill, or else adopt some method of lengthening out the drill already in hand. One method is to make an extension shank to fit the ordinary square shank of a bit stock drill. Edwin Kilburn, Spring Valley, Minn., sends the sketch of a device which he recently made for this purpose and which proved very satisfactory. The body part *B* was made of a piece of steel tubing ½ inch outside diameter, which was brought to a red heat for about 1 inch at one end, and this end was driven down over the shank of a drill held in a vise. A very little hammering made a first-class square socket and one which exactly fitted the drill. To enable the device to be used in a bit stock a shank which had been broken off a drill and which was of the right size to fit inside the tubing was brazed in as shown at *A*. This made an extension holder which held a drill almost as rigidly as though it were a solid piece and also possessed the further advantage that it was little, if any, larger in diameter than the drill, a point which is many times as much of an advantage as the increased length.



Industrial Press, N.Y.

HANDY PLANER AND SHAPER CLAMPS.

"Toolmaker" sends the sketch of a style of planer clamp which he recently found very convenient for holding some long, narrow pieces that could not be handled in a chuck or held down by straps. Some pieces of iron or steel 1½ inch square by 5 inches long were turned down at *A* to fit the holes in the platen of the planer. At *B* a hole was tapped, at an angle of 10 degrees with the horizontal, and fitted with a ⅝-inch cup-pointed setscrew. Pieces of square, self-hardening steel were cut in lengths of about 2½ inches and a point, similar to that on a center punch was ground on one end. The other end was ground round to fit the cup point of the setscrew. These pieces are placed with their pointed ends against the work and the other ends in the cup of the screws as shown in the sketch. In this way the work is held very nicely. If the marks caused by the points will injure the work, a piece of sheet metal can be placed between the work and the point. The marks, however, will be slight, as the clamping force required to hold the work firmly is very small.



Industrial Press, N.Y.

MILLING ANY ANGLE.

Robert A. Lachmann, informs us of a very neat "kink" recently brought to his notice for milling flats on shafts, or similar work, whereby the proper angle can be obtained by movement of the milling head without the use of a bevel protractor. The scheme consists simply in setting the sector for three holes on the 27 circle. It is obvious that a movement of three holes on the 27 circle (with a worm and gear whose ratio is 40 to 1, as is generally the case) will give 1-360 of one revolution of the work, or a movement of 1 degree, so that any angle can be accurately cut by this method. For example, if a movement of 9 degrees is required, one full turn of the indexing crank will be required, since 27 ÷ 3 gives 9-360 of a complete revolution of the work or a movement of 9 degrees. Similarly, 10 turns of the indexing crank will give 90 degrees which would be used when milling a square.

SHOP USE FOR PLASTER OF PARIS.

J. B. C. writes: It is doubtful if you would find plaster of Paris in many machine shops at which you might inquire for it, yet it has frequent utility. Fig. 1 shows the section of a thin casting which is to be finished on the inside and outside while Fig. 2 represents, exaggerated, the shape which it assumes when secured in a four-jaw chuck. Of course the work will not be round when it is removed from the chuck. If the side to be chucked is filled with plaster this difficulty is avoided. Fig. 3 is the expansion member of a clutch and is to be turned on an arbor. However slowly and carefully this turning is done the work will chatter and the finished piece will be neither round nor concentric. Here again plaster eliminates the difficulty and allows the turning to be accomplished with ease. After the work is finished the plaster can be readily broken up and removed.

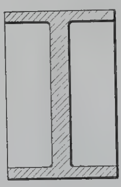


Fig. 1

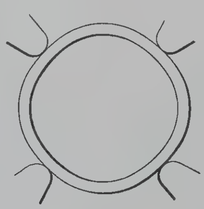


Fig. 2

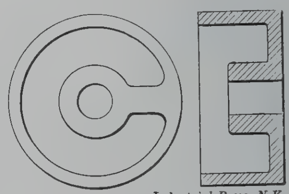

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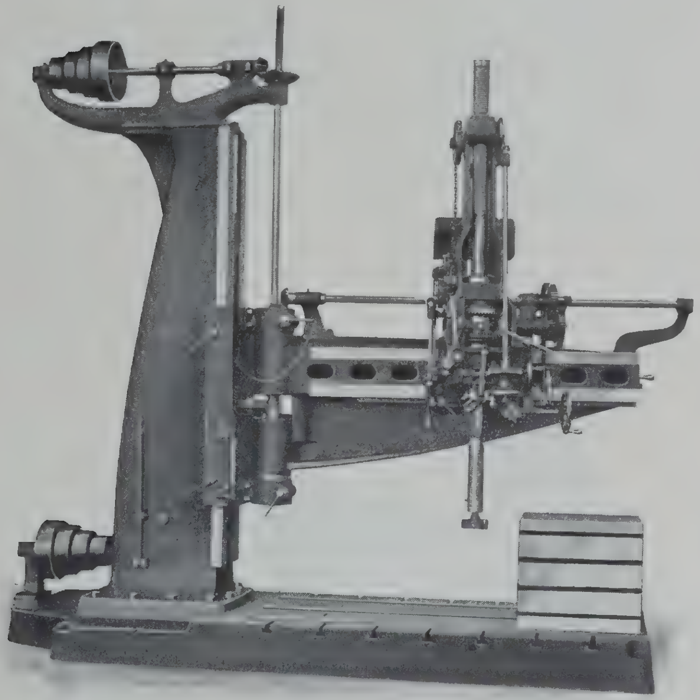
Fig. 3

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

SEVEN-FOOT TAPPING RADIAL DRILL.

The Fosdick Machine Tool Co., Cincinnati, Ohio, have recently brought out a 7-foot tapping radial drill that is especially adapted to locomotive works, railroad shops, and shops of like character where unusually heavy drilling and tapping are done. This drill is capable of drilling to the center of a 172-inch circle while the greatest distance from the spindle to the base is 90 inches. One of the distinctly new features of the machine is that it has a positive thread-cutting attachment for 8, 10, 12 and 14 threads per inch, for heavy tapping, and four positive geared drilling feeds. The spindle has a traverse of 30 inches and is counterbalanced to facilitate operation.



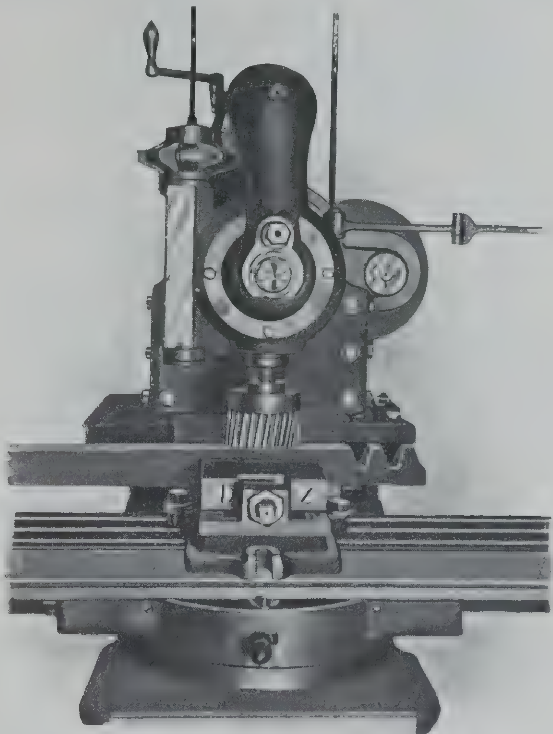
Special Seven-foot Radial Drill.

The back gears are located in the head, thus bringing the power direct to the work. All operating levers are located on and travel with the head and are therefore always directly in front of and convenient to the operator. A quick return permits of engaging the power feed instantly. The various special features of this machine make it capable of taking care of certain classes of large work, heavy drilling, tapping, etc., to much greater advantage than is possible with the plain radial drill. In the locomotive works these drills are being used on heavy drilling, reaming and tapping especially on cylinder guide yokes, link hangers, rockers, cross heads, etc., also for hubbing off the bosses on rocker arm hubs, link hanger hubs, valve gear transmission rods, etc., with a box tool.

ATTACHMENT FOR MILLING SPUR GEAR RACKS.

James & Foote, Chicago, Ill., have just brought out the milling attachment illustrated herewith, which is designed for milling the surface of spur gear racks and cutting the teeth in them. It is capable of using large face mills and will carry rack cutters up to 2 diametrical pitch. The attachment is secured to the frame of the milling machine by a saddle clamped to the vertical ways. This saddle has an annular T-slot provided with bolts which clamp it to the milling head but at the same time allow the head to be swung around at any angle, the position being indicated by a set of graduations on the base.

The horizontal shaft is inserted in the cone spindle of the milling machine and from this the vertical shaft of the attachment is driven, through a pair of miter gears which allow it to swing through the whole circle. The end of this vertical spindle is threaded to fit the same chuck as the machine spindle and is reamed to Brown & Sharpe No. 10 taper. The rack cutting spindle is driven by steel spur gears and fitted to carry Brown & Sharpe standard rack cutters. After milling the surface of the rack with an end mill, as shown in the illustration, the head is swung around, through 90 degrees, so that the rack cutting spindle, shown here in a vertical position, will be brought horizontal and the teeth of the rack are then milled in the ordinary manner.

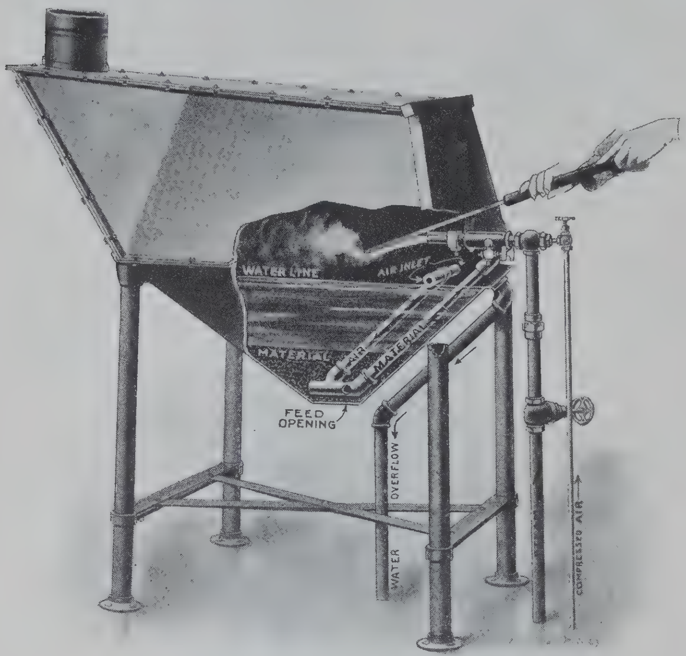


Attachment for Milling Spur Gear Racks.

A FILE SHARPENING MACHINE.

Owing to the fact that as a rule the cost of files goes into the miscellaneous shop expense and thereby loses its individuality, very few manufacturers realize what a large source of expense their files are to them. A file is different from any other edge tool in that it can only be used for a short time before an infinitesimal portion of the head of the teeth becomes worn off and the file, for all practical purposes, becomes worthless although in all respects except its cutting qualities it is as perfect as ever. Many manufacturers then throw their dull files on the scrap pile, unless they have them recut which is often unsatisfactory on account of the temper and size being changed. But they do not throw away their other edge tools when they become dull; they sharpen them up again. Since the first files were made, experiments without number have been tried whereby a dull file could be restored to its original usefulness without changing its size or temper, and thus rendered suitable to be used again.

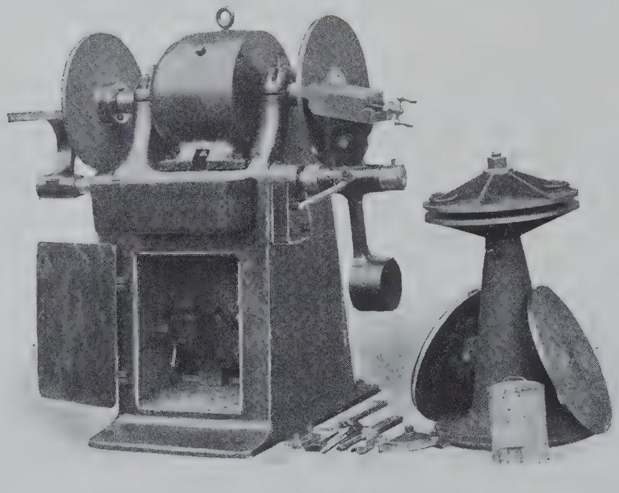
The illustration herewith shows a new machine for this purpose which is the invention of Mr. A. H. Radell, and is being placed on the market by the American Steel Tool Co., Chicago, Ill. The machine is operated by means of steam alone, or a combination of compressed air and steam may be used. By means of a suction blast the abrasive material, which is carborundum, is forced against the back of the teeth of the file at an angle of from 15 to 30 degrees. The file is drawn up and down over a nozzle inside of which is a reducing jet so that the material strikes the teeth from the back and cuts away a portion of the metal wherever it has a point of resistance, thus restoring to the file its sharpness and cutting qualities and preserving the original angle of the tooth. This treatment does not disturb the temper of the file nor does it perceptibly alter its size. On account of the angle at which the file is held and at which the abrasive material strikes it, the point of the tooth is protected since the material travels up the back following the original angle of the tooth instead of striking directly and so dulling it. After impinging against the file, the material settles to the bottom of the machine and is used over and over again until it is gradually cut up and carried away in solution by the overflow outlet. With this machine it is possible to sharpen 100 to 300 files per day, of all shapes and sizes. Ordinary files may be sharpened from two to six times, according to the depth of the tooth, and they may then be recut in the ordinary way and used and sharpened as many times more.



Machine for Sharpening Worn Files.

UNIVERSAL MOTOR-DRIVEN DISK GRINDER.

The Ransom Mfg. Co., Oshkosh, Wis., have just brought out an 18-inch universal motor-driven disk grinder which is illustrated herewith. The armature of the motor is wound on a sleeve which is pressed onto the spindle of the machine. The motor, which is multipolar and compound wound, is of the enclosed type, the enclosure being accomplished by means of spun copper hoods the upper half of which can be removed when it is necessary to adjust the brushes. The shaft carries on each end a grinding disk and the end play is taken up by means of jam nuts which are placed on each side of the left hand box. Heretofore the practice has been to place the jam nuts on the inside of each box but this was found to have the objection that as soon as the armature shaft became a little warm it would expand and crowd the nuts against the inside of the boxes, causing them to cut. By the present arrangement this trouble is entirely overcome.



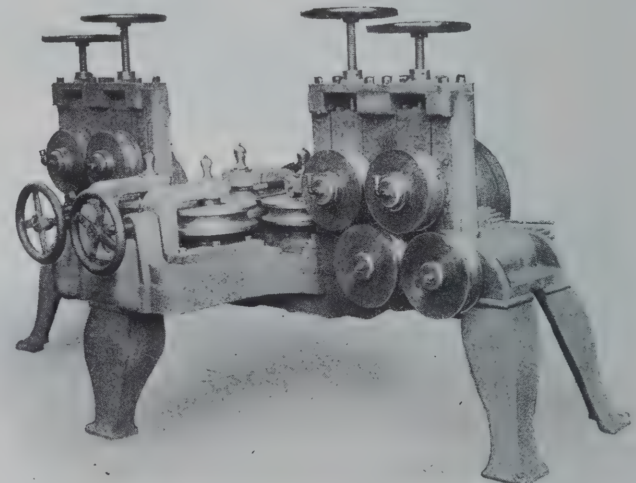
Motor-driven Disk Grinder.

A table is provided for each disk, that on the right hand end of the machine being universal in that it can be set at any angle. It has a screw feed toward the wheel and swings, on a shaft, across the face. This table is provided with T-slots so that any kind of templets or gages may be attached without the necessity of drilling holes in the table for this purpose. The machine is accompanied by a press and all of the accessories needed for preparing the grinding disks.

SHAFT AND TUBE STRAIGHTENERS.

Kane & Roach, Syracuse, N. Y., are placing on the market a full line of straightening machines which were designed by Mr. W. E. Kane for rolling mill use. The outside rolling machines, which are built in four sizes, have a capacity for straightening angles from 2 x 2 x ¼ inches up to 4 x 4 x ½ inches, and up to No. 40 railroad rails. They have eight rolls and are geared for two changes of speed.

The four sizes of inside rolling machines have overhanging shafts for extra outside rolls. They are built with either eight or nine rolls, the nine-roll machines having overhanging rolls on each end, can be run in either direction. These machines are built for either belt drive or direct connection with motor or engine, and in either case they are geared for two changes of speed. The capacity of the inside rolls ranges from 5 x 5 x ⅝-inch angles up to 7-inch round stock.



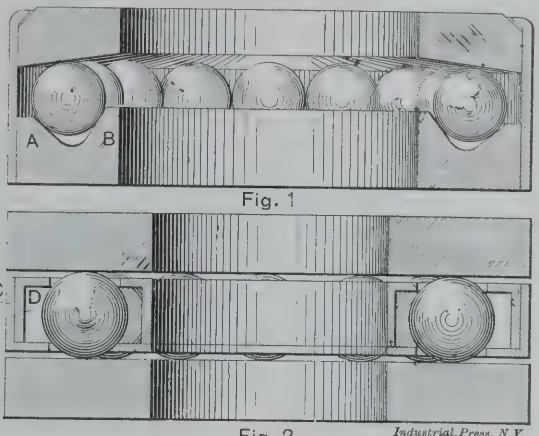
Shaft and Tube Straightening Machine.

The latest addition to this line of straighteners is the tube and shaft straightener illustrated herewith. These machines have twelve rolls, eight vertical and four horizontal, and they are built very long so as to have nearly a whole bar of shafting or tube in the rolls at one time. These machines range in capacity from 1-inch to 3-inch shafts and from the smallest tube up to those 8 inches in diameter. They are arranged for two changes of speed and may be driven by belt power or be direct connected.

NEW LINE OF THRUST AND RADIAL BALL BEARINGS.

The recently organized American Ball Co., Providence, R. I., have brought out a complete line of anti-friction bearings, including both thrust and radial ball bearings. The thrust bearing shown in Fig. 1, was designed to meet various requirements where it is desired to support the axial thrusts of shafts, the aim being to construct a bearing in which there would be rolling contact only between the balls and the raceways. The two points of contact *A* and *B*, on the lower plate, are in such a position in relation to the axis of the shaft that the rolling contact circles on the balls are in the same proportion as the contact circles on the plate. The contact on the upper thrust plate is in a plane parallel to a line drawn through the two points of contact on the lower plate, and it is therefore evident that no sliding will take place between the balls and the plate. The tendency to force the balls outward, on account of the difference of the angles of the lower plate, is counteracted by the angle of the face of the upper plate forcing them in the opposite direction.

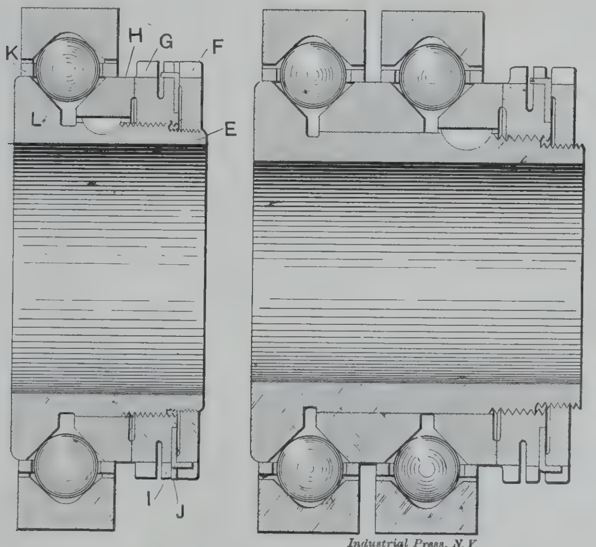
Fig. 2 represents the simplest form of thrust bearing, the principal point of novelty being the ball retaining cage. This is made of machinery steel and consists of two parts, an outer and inner cup, *C* and *D*, which are pressed together after the balls are placed between them. The thickness of the cage is nearly equal to the diameter of the balls contained in it, so that sufficient metal is left between the holes for strength while at the same time the balls are as close together as when no cage is used.



Industrial Press, N. Y.

"Reid" Ball Thrust Bearings.

In the application of radial ball bearings to machinery it has generally been necessary to make all parts of the bearing special or an integral part of the machine to which they are applied. Fig. 3 shows a sectional view of a single unit radial bearing that is self-contained, capable of adjustment for wear, and designed to cover a wide field of application. The lock nut, by means of which the adjustment is accomplished, is one of the especial features of the bearing. It is composed of an extended sleeve support *E*, formed with screw threads of opposite pitch, and the co-acting nuts *F* and *G* both of which are resilient in an axial direction at their contact portions. The inner face of the nut *G* is presented rigidly to the adjustable cone *H* while its opposite face is formed in the shape of a marginal resilient flange *I*. Between this flange and the engaging portions of the outer nut is contained a locking washer *J* which has flexible teeth adapted to co-act with the notched portions of the two nuts. The outer nut *F* is also resilient in an axial direction on account of the web portion between the outer contact portions and the inner threaded part not coming in contact with the inner nut. The notches forming the teeth on the periphery of the locking washer *J* are differently spaced from those on the two nuts. In adjusting the bearing the inner nut is screwed up until there is no play between the balls and the raceway, then the outer nut is forced up until one or more of the teeth on the locking washer can be bent into the notches of each nut, thereby forming a solid positive lock at any adjustment.



Industrial Press, N. Y.

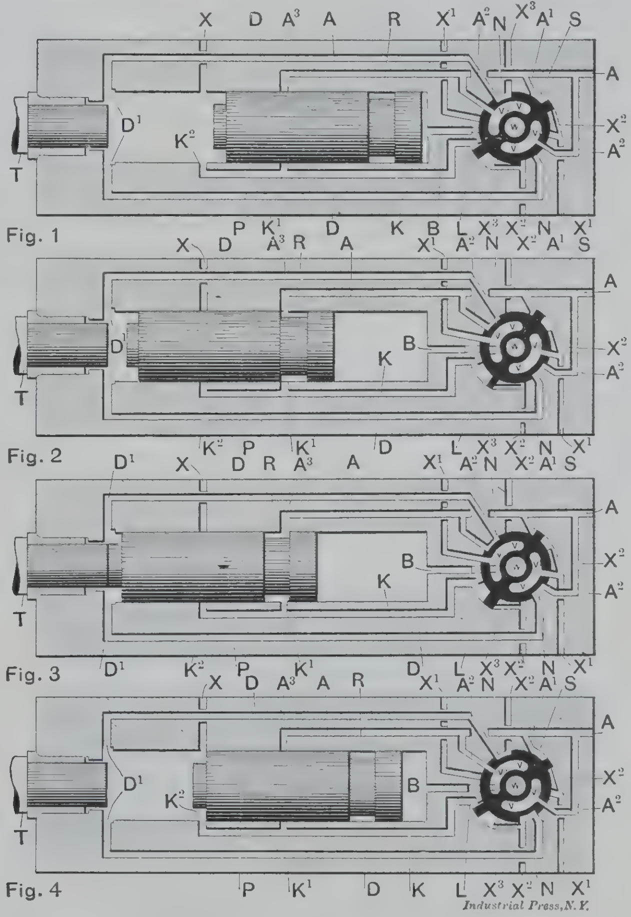
Figs. 3 and 4. One and Two Unit Radial Ball Bearings.

A ball separating ring, or cage, *K*, is generally used but may be omitted in bearings where the conditions do not require it. This cage consists of a ring which is made a running fit on the cones *L* and *H*.

Fig. 4 shows how this same type of bearing is arranged to form a double unit. In the same manner a number of units may be combined to form a bearing of any length desired. Accidents resulting from breaking of balls or cracking of the raceways are practically impossible with these bearings, as the sleeves are made a running fit on the shafts to which they are applied so that if a ball should break, and the bearing stick, the shaft sleeve would run on the shaft as in a plain bearing.

THE HAESELER-INGERSOLL PNEUMATIC HAMMER.

An entirely new line of pneumatic hammers has just been brought out by the Haeseler-Ingersoll Pneumatic Tool Co., of which the Ingersoll-Sergeant Drill Co., New York, are the general selling agents. The leading new feature about these hammers is the employment of what is called an "axial" valve, a photograph of which is shown in Fig. 5. The principle of this valve is that it oscillates about an axis which is in line with the center of the piston and the motion of the valve is consequently transverse to the direction of the piston movement. In this way vibration or reaction of the piston does not affect the motion of the valve and as the bearing is small, friction, and consequently wear, is considerably reduced.


X D A³ A R X¹ A² N X³ A¹ S
A
D¹
K²
X²
A²
T
Fig. 1
P K¹ D K B L X³ X² N X¹
X D A³ R A X¹ A² N X² A¹ S
A
D
B
K
X²
A²
T
Fig. 2
D¹ K² P K¹ D L X³ X² N X¹
X D R A³ A X¹ A² N X² A¹ S
A
B
K
X²
A²
T
Fig. 3
D¹ K² P K¹ D L X³ X² N X¹
X D A³ A R X¹ A² N X² A¹ S
A
D¹
K²
B
X²
A²
T
Fig. 4
P K¹ D K L X³ X² N X¹

Industrial Press, N. Y.

Sections showing Operation of the Axial Valve.

Figs. 1 to 4 are diagrams showing the ports spread out in place so that the action of the valve may be traced, the valve itself being indicated by the heavy black lines. As will be seen this valve is always balanced owing to the ports being diametrically opposite, and is always subjected to equal pressure.

Referring to Fig. 1, it will be seen that full pressure enters *A* and passes down into the space *S*, and acts against the short vane, holding the valve in the position as given in Fig. 1, full pressure air then enters through a tube and a port in the valve $V1$ and passes down to the back of the piston throwing the piston forward, when the slot R passes a port in cylinder $A3$, full pressure air is allowed to pass out through the port $K1$ and up through K into space L and acts on the opposite side of the long wing which immediately throws the valve to its second position in which the space back of the piston is open to the outside air through the valve at $V1$ and the port $X1$. At the same time suitable slots in the valve connect the full pressure air supply with the passage $D1$, which leads to the front of the piston, thus admitting full pressure air in front and throwing the piston back to its original position. This does not occur, however, until the piston has expended its full energy on the end of the chisel blank, as shown in Fig. 3. As the piston moves back it exposes ports $K2$ to the air through X, which allows the air in the front of the piston and also in the space L to exhaust, allowing the full pressure air which comes in through A to throw the valve to the original position as shown in Fig. 1. This cycle is repeated with a rapidity which depends on the air supply at A, which is governed by the throttle.

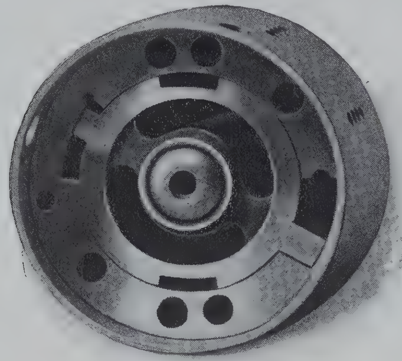


Fig. 5. "Axial" Valve of Haeseler Pneumatic Hammer.

The valve, which is a small, light forging, works on a central bearing which forms a part of the valve box. This box has a cover, and both box and cover are provided with dowel pins, which insure their dropping into place when they are put in the hammer. In this way the hammer can be taken apart or put together by the ordinary operator. Owing to the valve and valve box being independent of the handle, it is not necessary to have a lot of extra handles about, as is the case where the valve is in the handle, and a couple of extra valve boxes will keep a good size plant in operation owing to this interchangeable feature.

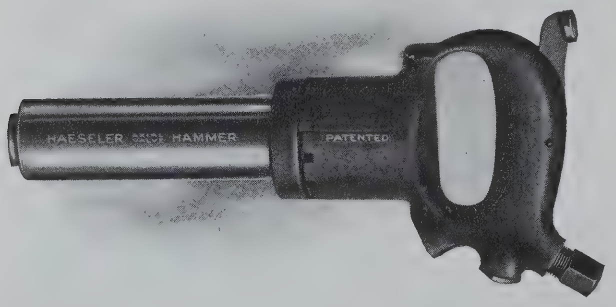
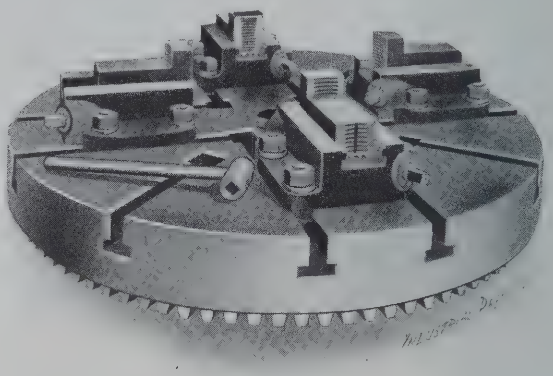


Fig. 6. Haeseler Pneumatic Chipping Hammer.

The efficiency of a pneumatic hammer is seriously impaired if the joints between the faces of the cylinder, valve box and handle are not kept tight. To insure keeping these joints tight, by securely locking the parts together, a simple and strong construction is provided by a number of slots which are cut in the collar of the cylinder while a different number of notches are cut in the other end of the handle, the one number not being a multiple of the other. This arrangement permits a fine adjustment to be made when it is desired to take up the wear of the parts, as a notch in the handle will always be in line with one of the slots in the cylinder, without regard to any required position of the handle being necessary. When the handle is screwed up tight, the parts are locked together by a key being inserted in the registering slot and notch referred to, and is held in place by a spring band being snapped over it and around the collar of the cylinder.

A SPIRAL GEARED CHUCK JAW.

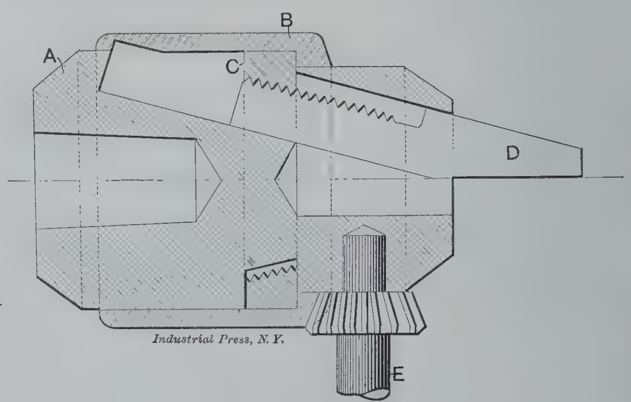
The new chuck jaw, illustrated in the accompanying halftone, has been adapted by the Bullard Machine Tool Co., Bridgeport, Conn., for use on their boring and turning mills and has been placed on the market for use with any chuck. For use on their own machines, the jaw is provided with four clamping bolts, suiting it to the parallel table slots; but it is also made with two bolts so that it may be attached to any faceplate having radial slots. Upon the under side of the sliding jaw is cut a rack which engages with the feed screw. This screw is set at an angle with the axis of the slide and the rack is cut at a corresponding angle, so that a powerful clamping force is exerted in the direction of the slide. The screw can be operated from either end and, being set at an angle, the wrench is thrown away from the work so that the operator has an opportunity to tighten the screw from the most advantageous position. Using a rack instead of a nut on the sliding jaw, permits the jaw to be made lower and therefore allows it to clamp the work much nearer to the face of the table than would otherwise be possible.



Boring Mill Chuck with Spiral Geared Jaw.

A NEW STYLE OF DRILL CHUCK.

The line cut herewith shows a section through a very novel drill chuck that has just been placed on the market by A. I. Jacobs, Hartford, Conn. Although resembling in general appearance, the ordinary drill chuck, the method by which it is operated is entirely new and has proved very efficient. In the main body of the chuck, A, there is turned a groove in which runs the threaded ring C. This ring is made in halves so that it can be placed in the groove and after it is put in, the sleeve B is forced over it. This sleeve runs loosely over the body of the chuck but fits the ring C so tightly that it forms with it an integral part of the chuck. Turning the sleeve B causes the ring to draw the threaded blades D, of which there are three, in or out, thus clamping or releasing the drill. The outside of the sleeve is knurled for turning it by hand and the front edge is cut with teeth for tightening it by the use of the toothed key E.

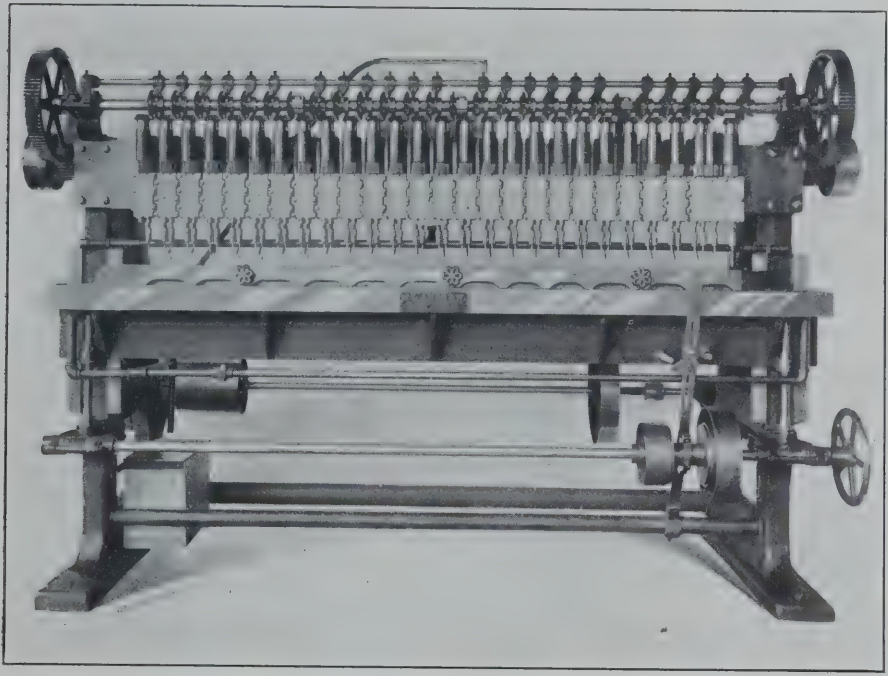


The Jacobs Drill Chuck.

This key is slipped into a hole in the nose of the chuck so that the teeth come into mesh with those on the front of the sleeve and enable a very powerful gripping force to be imparted to the shank of the drill. One of the advantages of this chuck over one in which the tightening is accomplished by means of a spanner or similar contrivance, is that while the spanner tends to turn the spindle, making necessary the use of one hand to prevent it, with this chuck there is no tendency for the spindle to turn.

FIFTY-ONE SPINDLE MULTIPLE DRILL.

A few years ago it was a rare thing to see a drill press or drilling machine of any kind that was equipped with more than a dozen spindles, but at the present day the number of spindles that may be applied to a drill seems to be limited only by the demands of the work. The accompanying photograph illustrates a vertical drilling machine, fitted with 51 spindles, that was designed for drilling steel cutter bars for reaping and mowing machines. With this machine the entire 51 holes are drilled in practically the same time that was formerly spent in drilling a single hole and the bars are all exact duplicates. The spindles are arranged to drill part of the holes as close as 7/8-inch, center to center, while the balance are drilled with 2 1/8-inch center distances. The former dimension is a fixed quantity but the distance between the latter spindles can be adjusted to suit different spacings of the holes. The steel bars that are drilled average about 78 inches in length by 7/8 inches in width, and are firmly held in a suitable chuck, which is drawn together with three small hand wheels. This chuck is made adjustable and can be set to bring the drills directly over the center of the bar.



Fifty-one Spindle Multiple Drill.

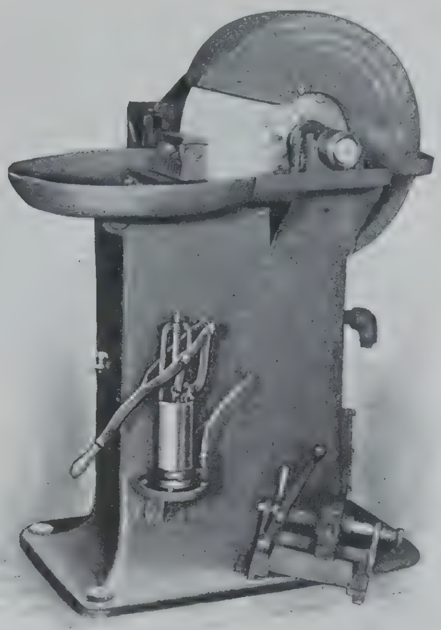


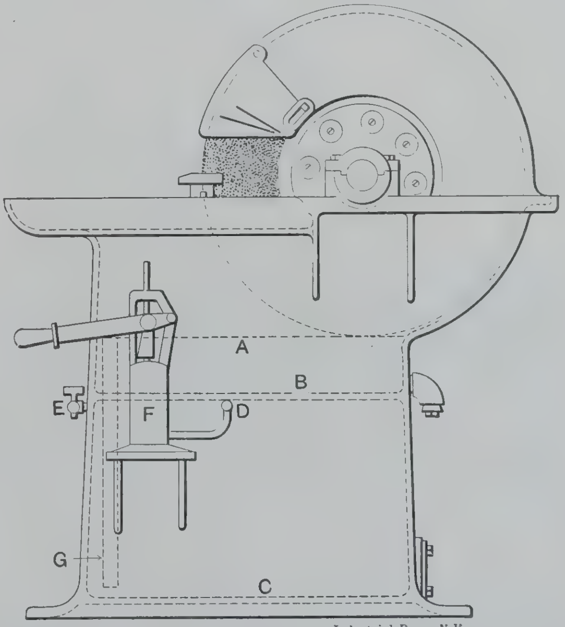
Fig. 1 New Water Tool Grinder.

The work is fed up to the drills with a strong friction feed and the table is returned with a 7 to 1 reverse feed. Automatic stops are fitted to the friction lever to regulate the travel of the table in both directions. An upper and lower tank is fitted to each machine with a geared pump between for pumping the drilling compound into the upper tank from which the drills are supplied. These machines are built in various sizes by M. L. Andrew & Co., Cincinnati, Ohio.

A NEW WATER TOOL GRINDER.

Since the advent of the use of an emery wheel for tool grinding it has been the aim of the grinding machine builders to provide for keeping a regulated supply of water upon the wheel. The method adopted by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., in a new grinder which they have just placed on the market, is illustrated in the accompanying cuts, Figs. 1 and 2. Fig. 1 is a general view of what is rated as their No. 3 grinder while the diagram, Fig. 2, shows the way in which water is applied to the wheel. The column of the grinder is divided into two compartments, or chambers, *A* and *C*, the lower compartment *C* being made air-tight. These two chambers are connected by the pipe *G* which runs from the normal water level in the upper chamber down nearly to the bottom of the lower chamber *C*. At the side of the column, supported on a bracket, is the pneumatic pump *F* which is connected by a small pipe to the air-tight chamber in the column.

When the machine is first set up, water is poured into the upper trough *A* and as soon as this is filled to the top of the pipe *G*, the water runs down the pipe into the lower chamber. In order to allow the water to flow into this chamber the pet cock *E* is opened so that the air may escape when the water enters. As soon as water begins to flow from the cock the chamber is known to be filled; the cock is then closed and the machine is ready for operation. Whenever the water in the upper trough falls below the normal level it is only necessary to introduce a little air into the lower chamber, by a few strokes of the pump, and this forces the water up through the pipe *G* into the trough. As the storage chamber is large and the pipe *G* runs nearly to the bottom, one filling is capable of lasting for an indefinite time and the weight of the water in the base also adds to the stability of



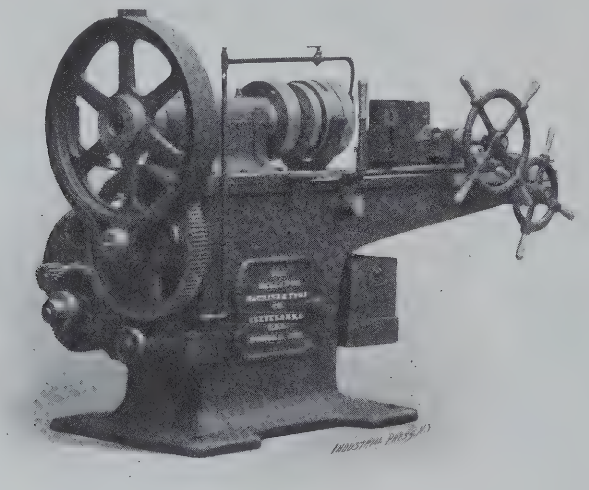
Industrial Press, N.Y.

Fig. 2. Water Tool Grinder, showing how Water is applied to the Wheel.

the machine. No parts of the pump in any way come in contact with the water so there is practically no wear or damage from dirt or particles of grinding dust that get into the water.

MOTOR-DRIVEN BOLT CUTTERS.

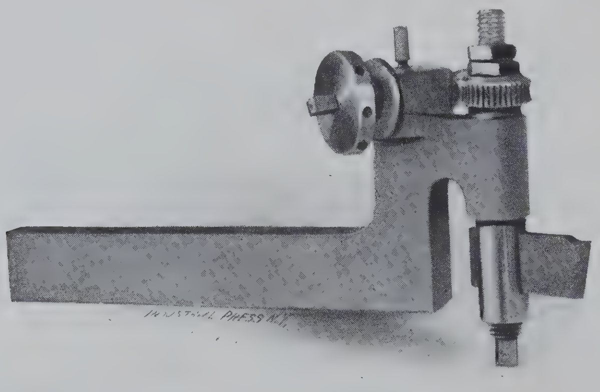
In line with the growing tendency toward electrically-driven machinery the Reliance Machine & Tool Co., Cleveland, Ohio, have just equipped their line of bolt cutters for motor-drives. The machine illustrated, which is the 2-inch cutter, is driven by a Crocker-Wheeler reversible, variable speed motor. The speed variation, obtained by field control, is as 1 to 3 and the motor is connected by means of spur gearing directly to the machine. The motor being fastened to the back side of the bolt cutter is readily accessible, free from grit and oil, and occupies very little floor space. The gears are carefully covered with casings which are not shown in the illustration.



Two-inch Bolt Cutter with Motor Drive.

A FILLET TURNING TOOL.

The difficulty and expense usually involved in making a radius tool, whenever it is desired to turn a fillet in a shaft or other lathe work, is well known to every machinist. It is also known that as the tool is fed in toward the center of the work it soon begins to cut metal on all sides and this inevitably produces chatter, especially with the larger tools. To remove this difficulty the fillet turning tool shown in the photograph herewith has been designed and is being placed on the market by Rabiger Bros. & Co., Philadelphia, Pa.

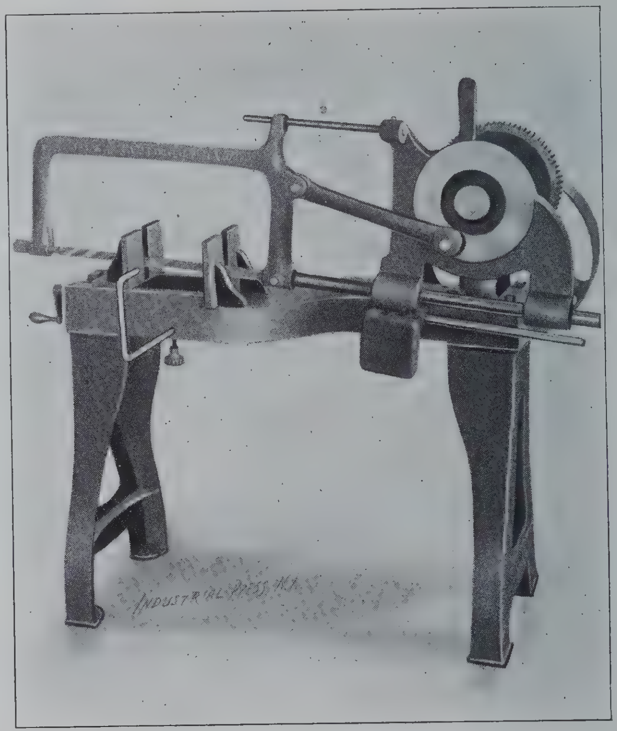


Fillet Turning Tool.

The shank of this tool is held on the carriage in the regular manner while the cutting tool is clamped in the revolving toolpost which is rotated by the worm and worm-wheel. The worm may be operated by hand even when heavy cuts are being taken, but the operating knob is drilled for the application of a spanner or lever when the work is too severe for hand feed. To obtain any required radius it is only necessary to set the tool in or out from the center of the revolving toolpost the required amount. The tool may be instantly adjusted to any position by removing the small pin and turning the eccentric knob, shown back of the feed knob. This disconnects the worm from the worm wheel and leaves the toolpost free to be turned at will. Curves of any radius can be cut with this tool and, having once set the cutter properly, it is impossible to make a fillet of wrong radius or to cut other than an accurate curve.

ROBERTSON POWER HACK SAW.

A new power saw that has just been placed on the market by the Robertson Mfg. Co., Buffalo, N. Y., is illustrated in the half-tone herewith. This saw is gear driven, operating the saw blade at a rate of one stroke per four revolutions of the driving pulley. A sliding bar with top guide and crank connections all in center line with the saw insures a true stroke. The swing carriage with large bearings allows the saw frame to travel naturally and mechanically in the cut and at the same time raise on the return stroke relieving the drag on the teeth. The sliding weight can be instantly adjusted for different hardnesses of metal. A stud back of the vise, stops the machine when the work is completed and a flat lever then holds the frame up automatically. An adjustable gage is provided for cutting bars, disks, pipes, etc., to exact length. This, the No. 3 size, has a capacity for cutting work up to 8 x 8 inches.



Robertson Power Hack Saw.

THE "SIMPLEX" VARIABLE SPEED COUNTERSHAFT.

In modern shop practice, especially when using the new high-speed steels and motor drives, there is a growing demand for closer speed regulation than can be obtained by the use of cone pulleys or geared drives, as the variations in speed obtained in this way must vary by comparatively large steps. A countershaft is therefore required in which the variations in speed may be made by finer gradations, since it is often desirable to effect a variation of as little as 5 per cent. in order to obtain the maximum efficiency from the tools. The "Simplex" countershaft, here described, is arranged to effect these variations by the use of two drums formed of wooden slats which travel in and out of milled slots in the face of tapered disks. One of these drums is driven at a constant speed, from the line shaft, while the other is mounted upon the variable shaft from which the machine is driven. Both shafts are carried in a substantial frame which also supports the mechanism by means of which the disks are operated. This mechanism consists of a pair of levers working together so that they simultaneously draw one pair of flanges apart and force the other pair together. The movement is effected by means of a pinion meshing with racks on the lever arms and is operated by turning a shaft placed at any convenient position on the machine.

The drums are connected by two wide belts for transmitting power and a narrow belt which so wraps around them as to retain the slats that are not covered by the driving belts. Between the drums is placed an idler which insures a constant belt contact of 270 degrees. As will be seen, the power is transmitted by direct belt pull at the face of the drum so that there is no twisting movement whatever and the loss of power in transmission is consequently very small.

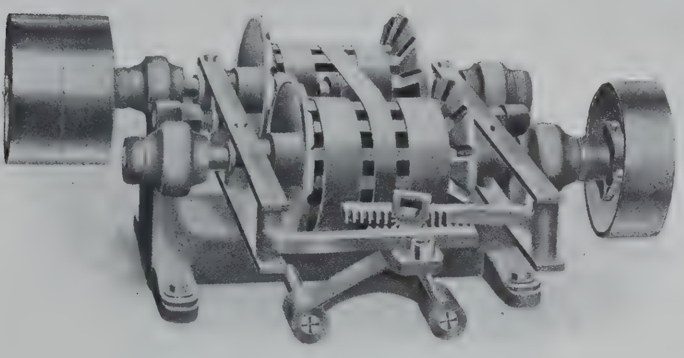


Fig. 1. "Simplex" Variable Speed Countershaft.

The action of the countershaft is clearly illustrated by the diagrams shown in Fig. 2, in which *C* represents the shaft running at a constant speed and *V* is the shaft from which the machine is driven and which runs at a speed that varies as the ratio of the diameters of the two drums is changed. The full black line represents the driving belt and the sectioned line is the retaining belt. In the first position shown the drum on the constant speed shaft is reduced to its smallest diameter and the variable speed shaft is consequently driven at its slowest speed. The last view shows the constant speed drum raised to its largest diameter, in which case the variable shaft is driven at its greatest speed. The total variation of speeds obtainable is 10 to 1

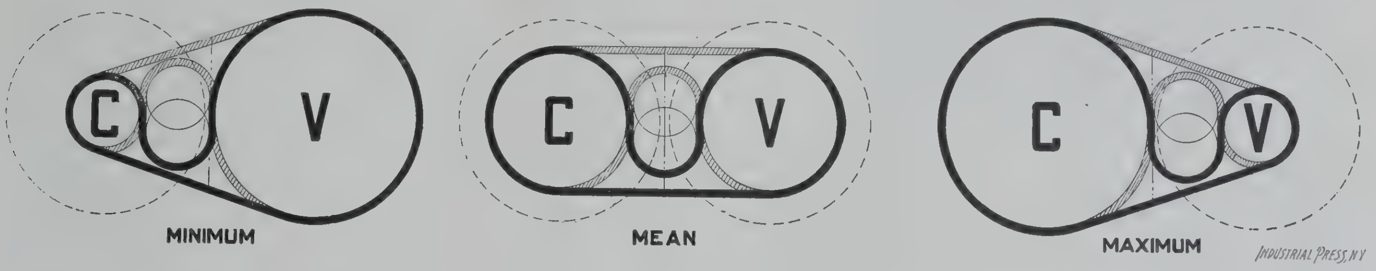


Fig. 2. Illustrating the Action of the "Simplex" Countershaft.

When the mechanic has discovered the most efficient speed at which his machine should be driven he desires a mechanical device to indicate this speed so that, in the future, when he has occasion to use the same speed he can immediately adjust the countershaft to obtain it. By such a device he can tell at a glance whether his machine is working at its full capacity. A device of this kind is a part of the equipment of this countershaft, and it is known as the speed controller. On the face of this controller are scored efficient cutting speeds at which the tool should be driven and all that the operator has to do is to turn the hand wheel until the indicator finger registers the number for the particular case in hand.

This controller is also equipped with a device which will automatically increase the speed of the tool. For instance, on boring mills where the cut is from the outside to the center, by a series of worms and star feed the controller is arranged to increase the speed of the tool as it approaches the center. This countershaft is built in sizes from one to five hundred horse power by the Speed Control Co., Philadelphia, Pa.

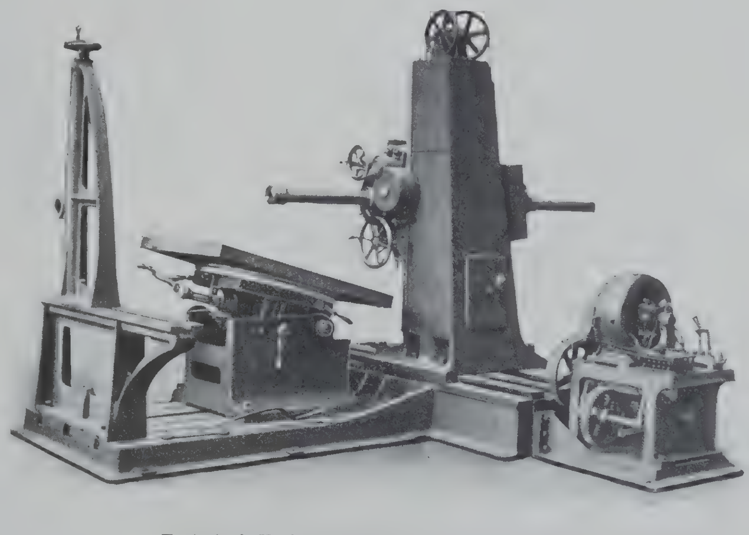
A RAPID REDUCTION LATHE.

The Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, have brought out a "rapid reduction" lathe designed especially for heavy turning with the new high-speed tool steels. The bed is of unusually rigid and heavy construction and of such form that the downward pressure of the cut will come directly under the tool. The carriage and tailstock are carried on independent ways, at the front and back of the bed respectively, so that it is possible for the carriage to pass entirely by the tailstock. The power feed is operated from the apron and may be automatically released at any point by means of adjustable stops. The feeds range from 1-32 to 1-3 inch per revolution of the spindle for either turning or screw cutting. Provision is made on the carriage for using two or more tools which are carried in independently adjustable tool blocks. The lathe is driven by a 6-inch belt running on a three-step cone pulley and all the gearing of the headstock is carefully guarded with iron casings.

FORTY-INCH HORIZONTAL BORING AND DRILLING MACHINE.

A machine that is adaptable to a very wide field of shop use is the horizontal boring and drilling machine that is illustrated in the accompanying photograph. It consists of a bed plate on the high portion of which is fitted a column that is arranged to have longitudinal traverse. On this column is a saddle carrying a spindle which is provided with a geared feed motion and the end is arranged for a Morse taper. The saddle is fully counterbalanced and is raised and lowered by hand. The spindle is moved by hand, either slowly for feeding or rapidly by spoke wheel for quick adjustment, and in addition it has several power feeds.

To the other portion of the bed plate is fitted a universal table which is capable of handling work of several thousand pounds weight. This table has a sliding movement to and from the column, being operated by a rack and pinion. The top has a pivoted movement, from a horizontal to a vertical plane, and can be rigidly clamped at any angle. It also has a rotary movement which makes it possible to drill holes in any part of a hemisphere or in five sides of a cube without rechucking the work. If large work is to be machined the table can be removed from the bed. When the machine is used for boring, an outside support for the bar is provided which can be used either with or without the universal table. Steel scales for accuracy of adjustment are furnished if desired.

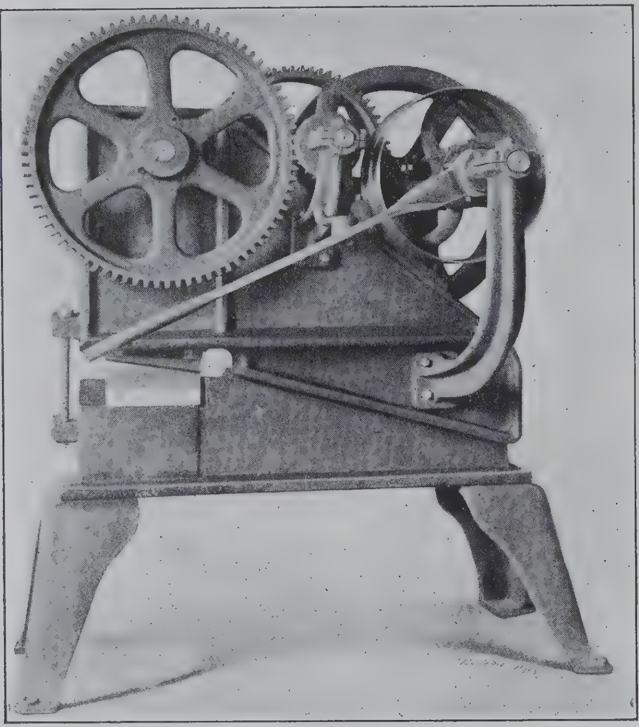


Forty-inch Horizontal Boring and Drilling Machine.

When the machine is motor-driven, as in the illustration, a special arrangement of cone gearing is provided to give the different speeds to the spindle without the use of belts. The machine is manufactured by the Detrick & Harvey Machine Co., Baltimore, Md.

BOILERMAKERS' SPLITTING SHEAR.

The machine shown below is a boilermakers' splitting shear of the type having an offset frame in line with the throat, which permits the two parts of a plate being cut, to pass freely on each side without distortion, save that one piece is bent downward at a slight angle as it leaves the shear blade to pass under the offset portion of the frame. To make the matter clearer the frame section in the plane of the throat is made like one step of a stairs, and one piece of the split plate passes along the upper side of the step (on the opposite side of the machine from that shown) and the other portion along under the step on the side shown. The ratio of gearing is 20 to 1, and a clutch is provided for starting. The machine is made in three sizes for ½, 9-16 and ⅝-inch plates respectively, and in each size the shear blade is 10 inches long. When shearing plates the tie-bolt shown in the cut is removed, but it should be in place when cutting bar stock. The shear is made and sold by the W. C. Young Mfg. Co., Worcester, Mass.

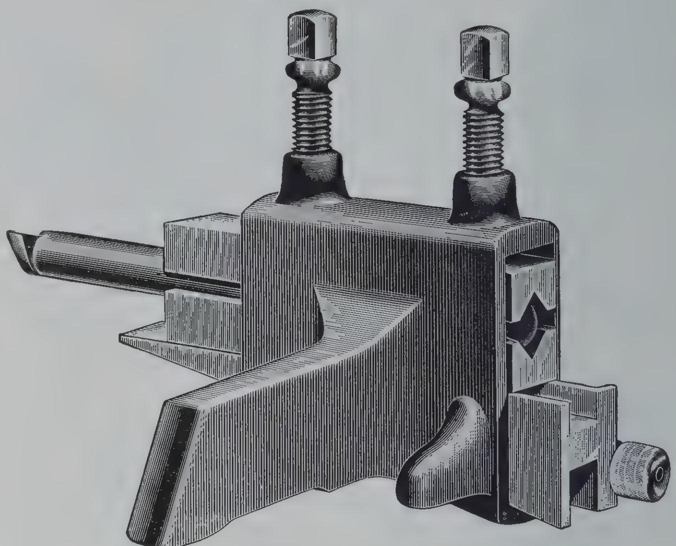

Boilermakers' Splitting Shear.

A QUICK RETURN FOR THE MILLING MACHINE PLATEN.

The Carter & Hakes Machine Co., Winsted, Conn., have recently adopted an automatic quick return mechanism for the table of their Lincoln type of milling machines. The purpose of the mechanism is to automatically and quickly return the table as soon as the end of the cut is reached. The return movement is thrown into operation as soon as the feed worm is released from its connection with the wormwheel on the feedscrew and, since it is driven from the countershaft by an independent belt, the return is always at the same speed irrespective of the speed at which the forward feed may be operating. When the quick return belt is not in operation it runs upon a loose pulley. A lever, attached to the end of the carriage, shifts the belt from this pulley onto the driving pulley as soon as the end of the table travel is reached, and thereby throws the quick return into operation. When the table has completed its return a dog engages the lever and throws the belt back onto the loose pulley again. The mechanism may be applied to any machines of this type and it in no way interferes with the regular arrangement for moving the table by hand.

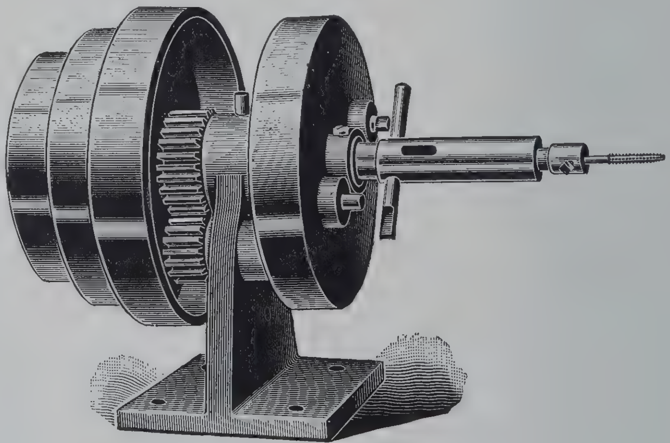
A UNIVERSAL BORING TOOL HOLDER.

The "Tiffany" universal boring tool holder which is illustrated herewith, was designed for general use with tools of round, hexagon or square steel as well as for holding flat, straight shank, and gun drills. The tool, which is held between two V-blocks, is rigidly clamped by two setscrews in such a manner as to insure no chattering. In addition to the adjustments obtainable with the usual type of tool holder this has the advantage of a vertical adjustment, which will be found often of great convenience. The vertical movement is obtained by loosening the two clamping screws and moving the wedge in or out by means of a knurled thumb screw and taper wedge. This keeps the cutting tool constantly parallel with the work. These holders are made in three sizes and their sale is controlled by the Miami Valley Machine Tool Co., Dayton, Ohio.


Universal Boring Tool Holder.

AUTOMATIC TAPPING MACHINE.

A new and very convenient tapping machine, capable of tapping holes up to ⅜-inch, is illustrated in the cut herewith. The mechanism is so arranged in the casing that the spindle will stop after the reverse on each tap, leaving it stationary while the machine is running at full speed. This enables the cone pulley to act both as tight and loose pulley, and backing and feeding belts are not required. The tap on reaching the bottom of the hole reverses at a speed two and one-half times as fast as the feed and there is no friction whatever occasioned by the reversal. This machine is the product of the Atlas Machine Tool & Die Works, Cincinnati, Ohio.


Automatic Tapping Machine.

J. W. Bourn, who for the past year has been a foreman in the machine shop of the Gruson Iron Works, Eddystone, Pa., has tendered his resignation and has accepted the position of assistant superintendent of the George V. Cresson Co., Philadelphia.

MACHINERY.

August, 1903.

CONCRETE FOUNDATIONS.

PRACTICAL HINTS FOR BUILDERS OF MACHINERY FOUNDATIONS.

R. P. KING.

From time to time during the past few years there have appeared in the columns of the technical press, articles pertaining to foundations and methods of anchoring machinery to them. Several years ago I assumed my first responsible position and a few months later was called upon to put down foundations and set up machinery amounting to some $20,000. The drawings were from the office of a consulting engineer and were "non-committal," to say the least. I was certainly "up against it." I seached my file of papers for the articles referred to, but when found they told me next to nothing of the nature and qualities of cement, lime, sand, stone or brick. A little book on "Foundations" was purchased but proved to be an exposition of the foundations of immense structures, those of the East River bridge occupying a large share of the book. I did not know, at that time, that the information I was in search of was contained in text books and papers on civil engineering; as it was, I just went ahead on my nerve and, as good luck would have it, I came out all right.

What I want to do in this paper is to tell a few of the things I have found out since that time—things that one is supposed to know but which a great many do not know.

The possibilities of concrete are almost without limit and one of its most "useful uses," is for the foundations of machinery. For both footings and piers it far surpasses either brick or rubble, both in excellence and cheapness. Concrete is, of course, composed of sand, broken stone or gravel, and cement; the proportions varying for different grades of material and classes of work. Sand is formed by the disintegration of various rocks and, like them, may be divided into three general classes: calcareous, silicious and argillaceous. The calcareous sands are those arising from lime-bearing rocks and while rare, are valuable for both mortar and concrete. The silicious sands are composed of quartz or feldspar and are the most common and valuable. The argillaceous sands are the clayey sands and are worthless for our purpose. Builders classify sand according to the size of the grain. When the grains run from 1-16 inch to ⅛ inch in diameter it is called coarse sand; while between 1-24 inch and 1-16 inch it is called fine sand. Any mixture of these two grades is called mixed sand.

Bank or pit sand is considered the best for concrete work as the grains are more angular and sharp than those of river sand. Under a microscope good sand will show a sharp and irregular appearance.

Bank and pit sand, is, however, apt to be mixed with clay or loam, and if this is the case it must be thoroughly washed before using. This is done by placing the sand in a large box and turning a stream of water on it. The box should have cracks in the bottom between the boards to let the water out, but the cracks should not be large enough to let much sand through. Sand may be washed in the wagon or cart in which it is hauled. After washing, the sand should have an opportunity to drain before being used. Perfectly clean sand may be rubbed between the fingers without soiling them. The amount of dirt left on the fingers after such handling is a good index of the cleanliness of the sand.

Sand for concrete work should not contain more than 40 per cent. of void. To determine this percentage weigh a bucket, then fill it with water and weigh again. A simple problem in subtraction will give the weight of water contained in the bucket. The water is then emptied into another vessel and the bucket filled with damp sand. Add water to the sand until the bucket is quite full and by weighing the water that remains determine the amount of water that has been added to the sand. The amount of water added to the sand divided by the total weight of water, will give the per cent. of void in the sand.

The gravel used in this work is nearly always found in connection with the sand. The mixed sand and gravel in the bank should first be screened over a screen having a ⅜-inch mesh; what falls through should be tested for voids and, if necessary, screened again to bring the per cent. of void low enough for economical working. The gravel on top of the screen should be screened again, this time over a 1½-inch mesh screen to remove the large stones. In good gravel the stones are hard, irregular in shape, and varying in size.

Broken stone makes rather better concrete than gravel but it is more expensive. Trap or volcanic rock makes the best concrete but limestone and quartz rock are often used—especially in the middle west. The stone should be graded from ¼ inch to 1 inch in diameter.

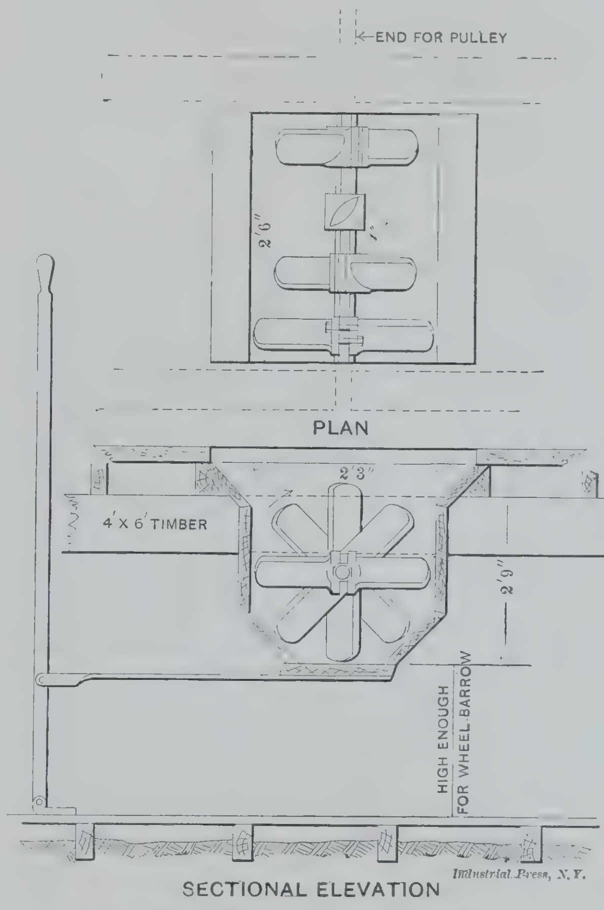


Fig. 1. Home-made Concrete Mixer.

Both gravel and broken stone should be well washed before using. This is done in a manner similar to the sand washing. In the case of broken stone the washing may be done just before using, thus avoiding the necessity of giving the stone an extra wetting; for dry stone would have a tendency to draw the water out of the concrete and should therefore be worked wet.

The cement used in concrete work should be of good quality; generally speaking the better the cement the better the concrete. Portland cement is the best and also the most expensive. If the finished work is to have considerable time to harden, a natural cement may be used. Rosendale in the east and Louisville in the west may be taken as characteristic natural cements.

As a rule the heavier cements are the best—Portland cement should weigh about 375 pounds to the barrel (net) with

Rosendale at 300 pounds and Louisville at 265 pounds per barrel.

The more finely ground the cement the better, as it is only the finest portion that has any value as cement. With Portland cement, between 90 and 92 per cent. should pass a sieve of No. 40 wire (Stubbs gage) 100 to the inch (10,000 meshes per square inch); and with natural cement 80 per cent. should pass through the same sieve. One soon learns by the feeling of cement as it is rubbed between the fingers, whether it is finely ground or not.

Natural cement should not take its first set in less than 10 minutes and should not require more than six hours for its final set. The term "first set" may be determined by a pat of neat cement supporting without indentation a ¼-pound weight on a wire 1-12 inch in diameter; final set by the pat supporting a 1-pound weight on a wire 1-24 inch in diameter. Portland cement should not take its first set in less than thirty minutes and should take its final set in not more than ten hours.

To sample a lot of cement in barrels, take an auger and drill into the barrel well toward the center. Enough should be taken out to make a pat some 3 inches in diameter and ½ inch thick at the center, tapering to ⅛ inch at the edges. The cement should be mixed with just enough water to form a dough and should be worked for several minutes, then formed into the pat. A piece of glass or an old plate is the proper thing to make the pat on. This pat should be watched to determine the first set and should then be covered with a damp cloth, for about 24 hours. At the end of that time it should be placed in water (plate and all) and kept there for several days or even three or four weeks. It should show no sign of disintegration along the thin edges, and no signs of distortion, or expansion cracks. Cement in bags may be tested by selecting samples from bags, at random, and mixing them together, then taking a sample from the mixture to form the pat. Cement showing lumps should be looked upon with suspicion and tested thoroughly.

If samples of cement fail in these simple tests it should either be rejected or taken to a person competent to conduct a more rigid examination.

The sand gravel, and cement, of satisfactory quality for the work in hand being brought together, the proportions for compounding next claim our attention. The ingredients should be thoroughly mixed and in such proportion as to secure economy of material and at same time to produce a substance resembling, as nearly as possible, the character of stone. The proportion of sand should be such as to fill the voids in the gravel, and the cement should just fill the voids in the sand. This is the most economical mixture obtainable. The void in ordinary sand will vary from 35 to 50 per cent.; therefore the difference in cost of concrete using the two extremes would be about as 4 is to 5, the difference being in favor of the sand having the less voids.

When the gravel contains 50 per cent. void, the proportion of sand to gravel will always be as 1 is to 2; with sand of 50 per cent. void the proportion of cement to sand will also be as 1 is to 2. In this case the proper proportion would be: 1 of cement, 2 of sand and 4 of gravel. If the sand contained 33 per cent. void, the proportion would have been: 1 of cement, 3 of sand and 6 of gravel. After once testing, the proportions would, of course, remain constant for any locality.

One part Portland and 4 or 5 parts of natural cement, make a very good cement to use for ordinary work, as it is stronger than all natural cements and is only a trifle more expensive. At the end of seven days the strength of natural cement is only about ¼ that of Portland. At the end of the first month the ratio is ½, the natural cement having gained strength more rapidly. For this reason, foundations built of natural cement should not be used for at least two weeks. Foundations of concrete should be of the same size as those of brick or stone, the weight of good concrete being about the same as that of brick and somewhat greater than that of rubble, but the allowable compression is greater for good concrete than for either brick or rubble.

For the best results, the concrete should be accurately measured and thoroughly mixed. The sand and gravel may conveniently be measured in rectangular wheelbarrows (not round bottom barrows) of suitable size and the cement may be shoveled into a box or other measure, or may be purchased in bags containing about one cubic foot (¼ barrel exactly)—which makes a convenient measure. In mixing, the ingredients should be turned at least twice—once dry and once wet.

When mixing by hand I dump the ingredients together on a plank floor and then shovel onto a new pile, mixing constantly with iron rakes. The pile is then shoveled over again in the same manner except that the proper amount of water is sprinkled on, during the mixing. For hand mixing the batches should not contain more than one cubic yard. Care should be taken to be sure that the time of mixing does not exceed the time taken by the cement for its first set, as the concrete should be in the foundation and well rammed before it takes its set. The water should also be measured and should be added by sprinkling rather than by pouring it all on at once.

No proportion can be given for the amount of water required but after a few batches have been mixed, one can readily determine this quantity. The concrete should appear to be just ready to show the water—perhaps as soft as plaster. If it is too dry, there will be holes in the foundation; and if it is too wet, it cannot be rammed at all. However, it is better to be too wet than too dry.

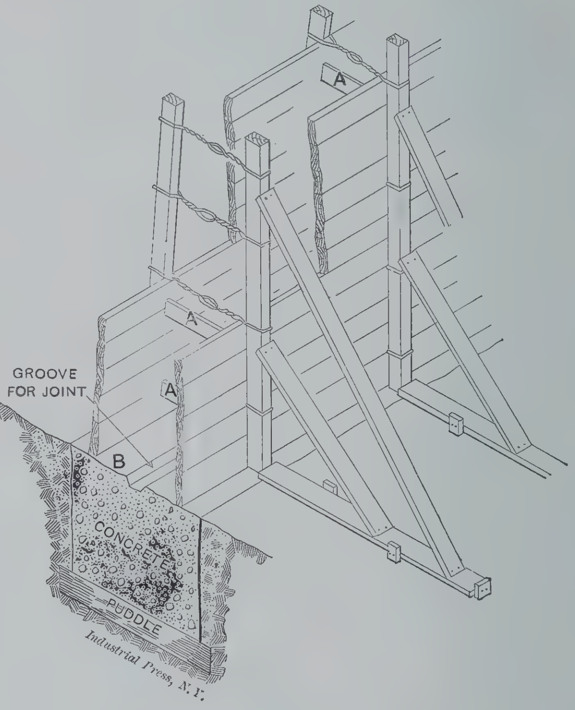
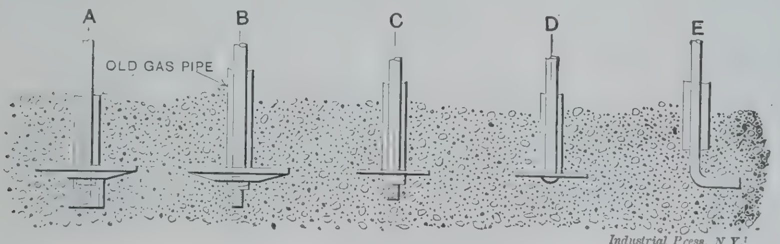


Fig. 2. Form for Concrete Work.

When putting it in, the concrete must be built up in layers of from 4 to 6 inches, and each layer thoroughly compacted by iron rammers. It is rammed sufficiently when the water comes to the top. The concrete should also be washed down along the edges of the forms with a spade to insure a neat looking job on the outside.

The best concrete is machine mixed; for with this method there is no tendency to slight this very important step. Fig. 1 is a home-made concrete mixer. The box may be made of any hard wood and is provided with a wooden or iron slide at the bottom, for removing the concrete. The revolving knives or mixers are bolted to an octagon shaft which has bearings turned on it and a pulley on one end. The speed should be about 40 revolutions per minute, and a 24-inch pulley with a 4-inch belt will drive it. The sand, gravel, cement, and water are put in from a platform, and the concrete is dumped into a wheelbarrow placed under the machine. The machine should be washed out every night after using.

I have not said anything about the forms for concrete work. Of course they must be strong, tight and smooth on the inside. Fig. 2 shows an isometric view of a form for a wall about 10 feet high. It will be noted that the wall is braced in three places, besides being wired. The wire is about No. 12 iron wire. The braces *AA* are loose, or only tacked in place, and are removed as the wall is built up. Do not nail the sheeting too securely to the studding. Any carpenter can put these forms up and the cheap, unskilled men that wheel the concrete may be employed to assist in the bracing and sheeting. Different methods of bracing the forms will readily suggest themselves to the mechanic in charge, to conform to the local conditions. Fig. 2 shows the wall with a footing extending several inches outside it. If the ground is firm, no sheeting is required for this footing, as the concrete is merely thrown into a trench and rammed. In any case the wall is brought up as far as the point *B* and allowed to set a few hours before the forms for the wall proper are started.



Industrial Press, N. Y.

Fig. 3. Anchor Bolts and Plates.

When designing foundations the different walls and piers should be made as nearly alike as possible, so that the forms can be made in sections and reset for new piers without alterations.

If possible, foundations should rest on hard pan, gravel, or hard clay. Made ground should be shoveled out for a depth of at least 12 inches below the bottom of the foundation and rammed as hard as possible. The 12 inches should then be filled with clay puddle, well rammed in place. The bearing power of made ground is only about 1 ton per square foot while the best of gravel or hard pan may run as high as 5 tons per square foot. The footings for the foundations should be proportioned with this fact in view, even varying the different parts of the same footing; the idea being to keep the settlement as uniform as possible.

If the bottom course of the foundation rests in water, the concrete must be treated a little differently. If there is only a few inches of water, say less than 12 inches, the concrete may be mixed dry and dumped carefully into the trench and slightly rammed. Should the water be much deeper the concrete may be mixed as for ordinary work, tied up in jute sacks, and the sacks laid closely in the trench, taking care to bond them together after the fashion of brickwork.

Proportion.			Required for one Cubic Yard.		
Cement.	Sand.	Gravel.	Bbl. Cement.	Cu. Yard Sand.	Cu. Yard Gravel.
1	2	4	1.34	0.41	0.81
1	2	5	1.17	0.36	0.89
1	2½	5	1.10	0.42	0.83
1	3	5	1.03	0.47	0.78
1	3	6	0.92	0.42	0 84
1	3½	7	0.80	0.43	0.85
1	4	8	0.71	0.43	0.86

After the foundations are finished to within ½ inch of the top, a layer of rich cement mortar, composed of 1 part cement to 1 part sand, should be put on, and swept off perfectly level with a straightedge. After this mortar has taken its first set it may be smoothed with a trowel. The sides may also be plastered with the same mortar and after it has taken its first set, lined off to resemble stone.

Fig. 3 shows several styles of anchor bolts and plates. *A* is an excellent arrangement, as is *B*. The other styles have little to recommend them except cheapness.

For important work such as engines and rolling mills, the foundations should be arranged with tunnels and pockets so that the bolts may be pushed down through the holes and the nuts and washers put on from below.

When the threads extend into the concrete they should be well oiled to prevent the concrete sticking to them, if it is expected to use the thread for adjustment.

Foundations having piers and tunnels should be provided with ample drains to carry off water and oil; these drains should be large and straight to facilitate cleaning, for they make convenient places for old shoes, bunches of waste, etc.

The cost of concrete depends on the quality of the structure and the location as regards raw material. The foundations of a building with walls of concrete arranged after the fashion of Fig. 2 will cost for labor about $2.00 per yard. This includes carpenter work, handling the material, superintendence, etc. For large and bulky foundations this cost will be less. Portland cement concrete bridge pieces have been put in for $3.00 per yard, complete, including materials and labor.

In estimating the cost of concrete the table in the preceding column, condensed from Thatcher's experiments, may be of value: It will be noticed that the material shrinks about 25 per cent.; this will vary with the amount of ramming the work receives. It might be well to note in the table herewith the fact that from 1—2—4 to 1—3—6 are the limits for first-class work; and from 1—2½—5 to 1—4—8 for second-class work. The weaker mixtures are to be used for filling or where the object is weight rather than great strength.

* * *

AMONG THE SHOPS.

NOTES FROM THE SHOPS OF THE OTT. MERGENTHALER COMPANY.

While in Baltimore, Md., a few weeks ago, several hours were profitably spent in the well-known shop of the Ott. Mergenthaler Co. It is a shop of more than ordinary interest inasmuch as it is the birthplace of the linotype machine, now used in almost all newspaper offices for composition. In fact many of the weekly and monthly publications, including MACHINERY, use linotype composition exclusively for their reading pages. The idea of casting a line or bar of type-metal, commonly called a "slug," from a row of female dies or matrices with the letters cut intaglio, is distinctly an original conception of Mergenthaler, and is what greatly differentiates his invention from other type-setting and type-casting machines. The name of the machine, "lin-o'-type," was a unique and happy thought, giving in a word an epitome of the principle. The linotype is not now built in this shop, the patents having been sold by Mergenthaler some time before his death to the Mergenthaler Linotype Co., of Brooklyn, N. Y. The shop is still run by the estate, doing high-class jobbing work and making linotype repair parts—an interesting specialty—also manufacturing the "Paradox" or Mergenthaler inserted blade reamer, and an inserted tooth milling cutter.

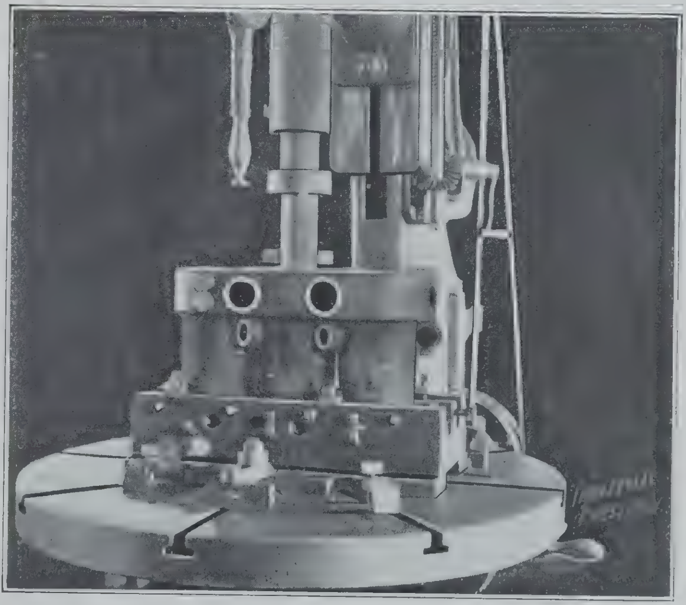


Fig. 1. Boring Three-cylinder Gas Engine on Drill Press.

To say that the reamer *per se* is an important tool in machine shop practice—in fact that it is indispensable wherever standard size holes and interchangeable work is being done—is but to state an obvious fact. It is also obvious that holes cannot be reamed to standard size unless the reamers themselves are kept to a standard. But to keep a set of solid reamers to a fixed standard is a job that costs a lot of money and time—too much in fact to be done in most shops. With an inserted blade reamer of reliable construction, however, the keeping of a set of reamers to standard size is easily within the possibilities of any ordinary tool-room. With a set of adjustable reamers there is the great advantage of being able to use them indiscriminately for all classes of work, and they can be made to do work on the drill-press that ordinarily would be reserved for the lathe or boring mill. The accompanying illustrations, Figs. 1, 2, 3, 4 and 5 illustrate a case in point which is work being done regularly in the Mergenthaler shop.

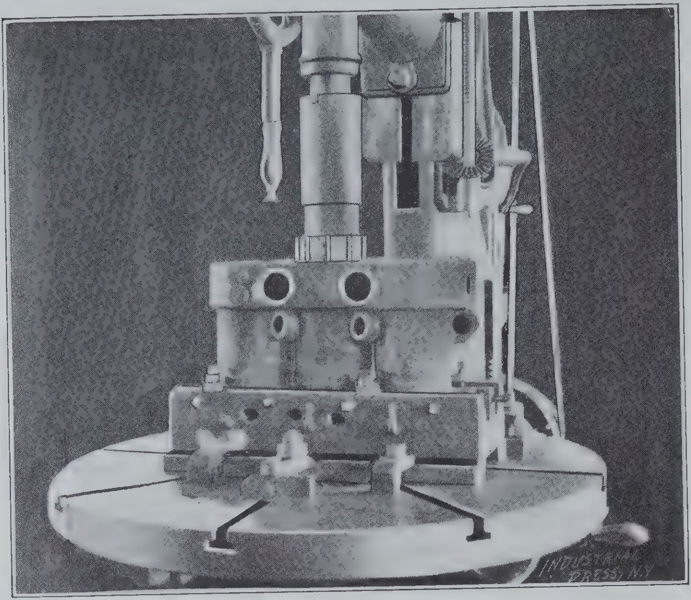


Fig. 2. Reaming Cylinders with Mergenthaler Reamer.

The casting shown in the half-tones is the cylinders of a three-cylinder gas engine, 4½ inches by 4½ inches, constructed for a leading automobile builder. Fig. 1 shows the cylinders held in a jig and being bored with a boring-bar carrying a two-ended cutter. The boring-bar is supported at the lower end by bushings in the jig, and the cutter removes the scale and most of the stock, leaving .020 inch for reaming to size. Fig. 2 shows a Mergenthaler inserted blade reamer of the shell type mounted on an arbor for finishing the bore. The arbor is made with two keys or feathers, diametrically located, for driving the reamer shell. The blades are preferably made short for work of this character in which the drill-press spindle supports and partially guides the tool, the blades being in this case about 1¼ inch long. With the short blades it is easier to make the hole perfectly cylindrical. The importance of boring the cylinders of gas engines as round and parallel as possible, is recognized by all gas engine makers, and some resort to expensive means for securing the desired result. The reamer seems to do the job nicely and in a very simple manner.

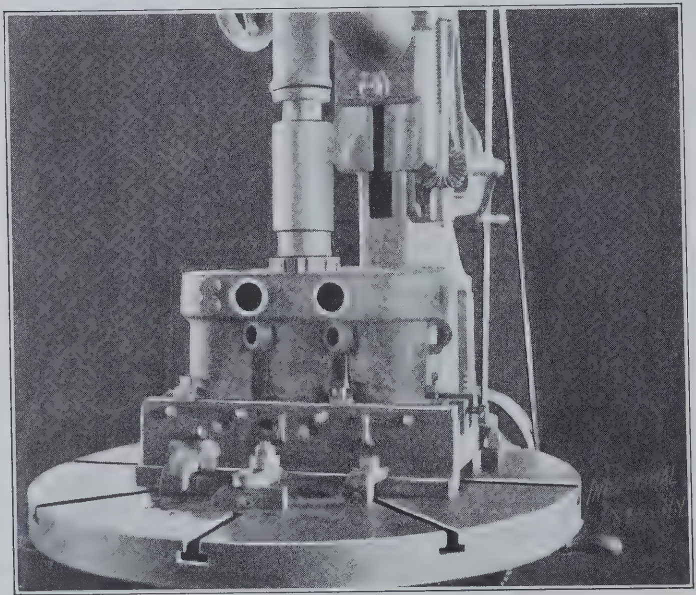


Fig. 3. Tapping Cylinders with Mergenthaler Tap.

In this gas engine the heads are screwed in, seating against a 3-degree bevel next to the counterbore. The threaded part is also tapered as in American pipe thread practice, and an inserted blade reamer is used for this purpose. Following the reaming of the tapered mouths of the cylinders comes the threading operation, which is done with an inserted cutter tap made on the same principle as that of the reamer. The tap for this purpose is shown in position for threading in Fig. 3.

In stating that the tap used is made on the same principle as the reamer, it should be explained that this applies to one style of reamer only. The simplest form of Mergenthaler reamer is made with a steel body having longitudinal slots in which each blade is held by two or more screws tapped alongside and holding the blade by their heads bearing upon a ledge planed on the blade below the cutting edge. Adjustment for wear is made by packing beneath the blades with thin strips of paper. The taps are made on the same principle, forming a solid yet adjustable construction. The universal adjustable Mergenthaler reamer is made so that all the blades may be advanced outwardly simultaneously. Each blade is underlaid with a wedge which can be moved longitudinally by a milled nut, and as all the wedges are made the same taper and all are given the same amount of longitudinal movement, all the blades move outwardly the same distance. In adjusting the simple type of reamer for wear it has been found to answer all practical purposes to compensate for slight wear by packing first under only one blade. A strip of thin cigarette paper under one blade usually suffices. Then as wear increases, the same thickness is packed under an adjacent blade, and so on until all have been packed out. While this practice may not seem exactly correct in theory, it has been found to work well in practice, and is the plan followed. The same applies to the taps.

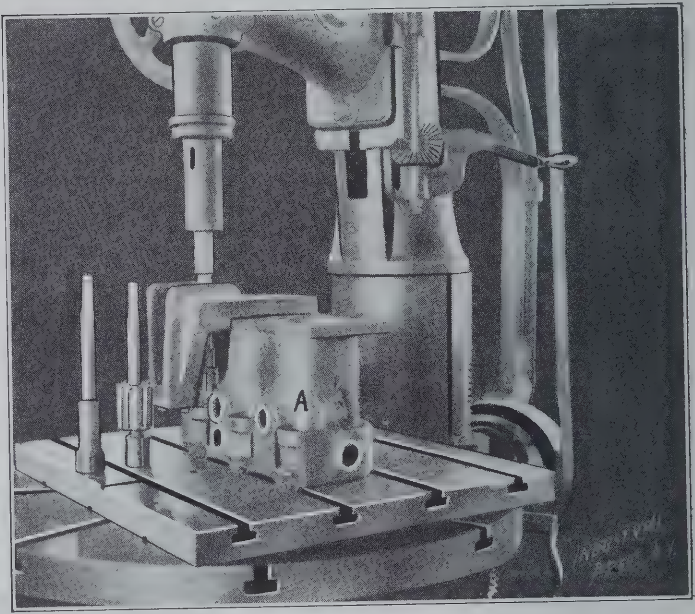


Fig. 4. Counterboring, Reaming and Tapping for Exhaust Bonnets.

Fig. 4 shows a cylinder casting on another drill-press table for the operations of reaming, tapping and seating the exhaust valve bonnets. One of the bonnets is shown in the line sketch, Fig. 5. These bonnets screw into the cylinders so that a tight joint is made under the shoulder; also on the surfaces *A A*. The cavity shown in the side of the bonnet matches a passage in the cylinder through which the exhaust gases escape to the muffler. While the pressure is not great it is very necessary that a perfect joint be made at *A A*, nevertheless, as the hot exhaust is very searching and would escape sufficiently under the back pressure of the muffler to be a nuisance, if it were otherwise than tight. A jig is clamped to the cylinder casting, and the reamer shown in place in the cut is first used to ream out the rough cored hole so as to form a guide for a pilot reamer which follows. The pilot reamer is shown standing on the table next to the casting. This reamer is unique in that the blades are inserted on a spiral. The pilot is made collapsible, that is, the pilot as it reaches the bottom of a cavity, may press its stem upward into the body of the reamer against the resistance of a coiled spring. This familiar expedient is, of course, simply to extend the working range of the pilot over what would be possible with a solid construction because of the limited depth of the holes. This reamer performs two functions: It surfaces the side of the casting so as to make a concave bearing for the finished sides of the bonnets already referred to. One of the concave finished surfaces is indicated at *A* in Fig. 4. The reamer also faces the surfaces against which the shoulders of the bonnets are screwed. From the nature of the work that this reamer has to do it will readily be seen why spiral blades are used. They work much smoother than would ordinary straight blades. In fact a reamer under the conditions imposed acts virtually like a milling cutter and performs the same function. Following the reaming operation is the tapping operation which is also done with an inserted cutter tap shown in the cut. It is not necessary to make the holes tapped in the castings for the bonnets bear a certain relation to the face *A*, Fig. 5. This face is brought in correct relation to the cylinder when screwed down tightly against the shoulder, by putting brass gaskets under the shoulders, the proper thickness being obtained by trial.

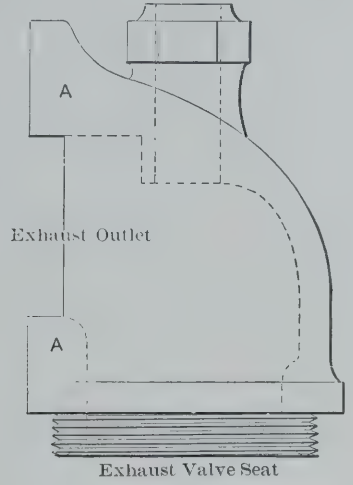


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Fig. 5. Exhaust Bonnet.

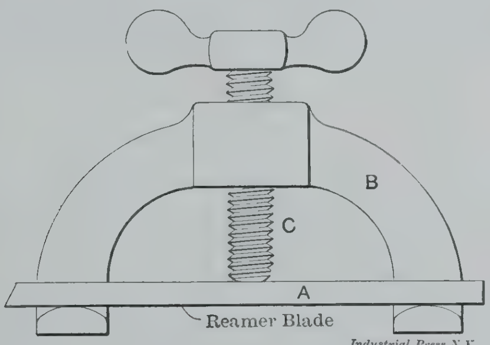

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Fig. 7. Clamp for Straightening Spring Reamer Blade.

The crankshafts for the gas engines are steel drop forgings. After the ends have been centered, rough turned and squared up, they are mounted in triangular cast-iron carriers, as shown at *A A′*, in Fig. 6. Two set-screws *D D* are provided in each to lock the shaft firmly. Three hardened steel cup centers are sunk in the face of each piece and, in location, coincide with the axes of the crankpins. The sides of the castings opposite the set-screws, are planed true and at equal distances from the center. In assembling a crankshaft for turning, the carriers are set on a surface plate on their planed edges with the crankshaft in place, but not firmly locked by the set-screws. The crankpins are then located so that their axes will coincide with the lines joining the cup centers, by the use of a surface gage. This is a simple matter. The gage pointer is set so as to just touch the upper side of crank *G′* and by the process of trial and error, the crank G″ is made to stand at the same height from the surface plate as *G′*. This being done, the cup centers *C C C* will be found to coincide with the crank axes. In turning the cranks it is the plan to avoid removing metal in the lathe if it can be done on the milling machine. Therefore the sides of the cranks, as at *F F*, are milled off with straddle mills instead of doing it slowly on the lathe with always the imminent possibility of having the tool catch and spring the crankshaft out of alignment.

The manufacture of reamers is distinctly separate from the making of linotype repair parts and the jobbing work. No pains are spared to make a first-class product in every particular. The general foreman is practically given *carte blanche* to use the best material and means for producing this product. An interesting phase of this work is hardening and tempering the blades. The hardening is done in a "dark room," that is, a room that is shielded from the direct rays of the sun so that the interior is in a perpetual gloom. This provision is, of course, so that the hardener can more easily determine the particular shade of "cherry red" which he has found best suited for reamer blade hardening. "American" gas furnaces are employed for hardening and tempering. In the hardening process it is inevitable that some of the blades will spring out of truth. These are placed in a clamp, Fig. 7, and a certain degree of pressure applied by the thumbscrew before tempering. The clamp with its blade are then dipped into a bath of Houghton's tempering oil which is kept at a temperature of about 450 degrees F. The temperature is indicated by a Queen & Co.'s glass thermometer immersed in the oil and as the oil bath is heated by a gas furnace, the regulation of the temperature to the exact degree required is an easy matter. Of course all the blades are tempered in the oil bath the same as those which are sprung, but these are dipped without being clamped, as are those that are sprung.

Among other interesting features of this shop which are the product of Mergenthaler's genius, are a number of his universal milling machines. Quite a number of these machines were built and sold. They are unique in a number of features, having for instance, geared feed. So far as we know this is the first knee-and-column type of milling machine built and sold having geared feed.

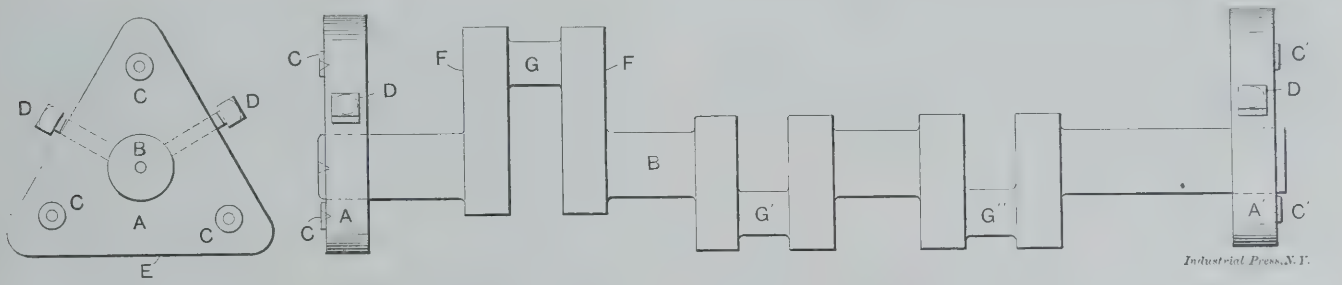

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Fig. 6. Carriers and Mounting for Turning Three-throw Crankshaft.

* * *

In a paper read June 4 by Dr. A. Haarmans of Osnabruck, Germany, before the Mining and Smelting Section of the International Chemical Congress held in Berlin, the statement was made that 19,000 tons of steel rails are annually ground to dust on the railways of Germany, and it was estimated that the total amount annually destroyed by friction on the world's railways, is about 247,000 tons. It was also stated that in Europe steel ties are now as cheap as wooden ones, the cost being of course based on their comparative durabilities.

ELECTRICAL EQUIPMENT OF AN ARCHITECTURAL IRON WORKS.

The shops of the Snead & Company Iron Works, Jersey City, N. J., have recently been completely equipped with Crocker-Wheeler electric motors, the installation including motors for driving both tools and cranes. These shops manufacture ornamental and structural iron and steel, and as the material handled is largely of a bulky nature, requiring considerable floor space, line shafting would have had three marked disadvantages: The necessarily long lines would consume an excessive amount of power in friction, would render the convenient placing of the driven members difficult, and with the accompanying belts would interfere with the crane and derrick facilities needed for handling the heavy product.

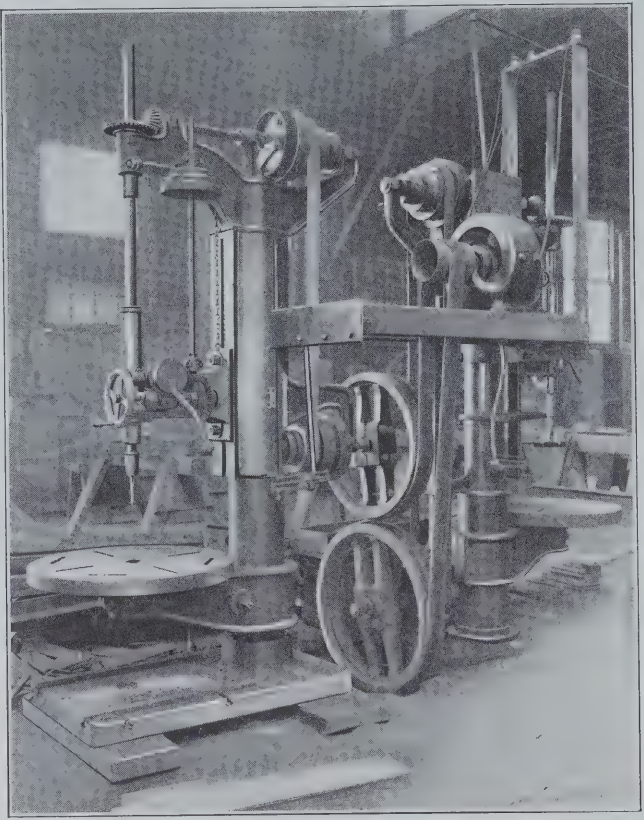

Fig. 1. Peculiar Belt Drive for Drill Presses.

The buildings, exclusive of the office, afford a total floor space of 31,350 square feet divided among the various departments, including foundry, charging-room, compressed air plant, fitting shop and box-shelf shop. The foundry is in a building 280 feet long by 52 feet wide, and is traversed by two cranes. One, which has been in use for some time, was built by the Yale & Towne Manufacturing Company, and is equipped with three Crocker-Wheeler series motors, with a new Niles crane similarly equipped. The blast for the cupolas is supplied by a Roots rotary blower, No. 6, driven at about 180 revolutions per minute through a geared connection to a 45 horse power shunt-wound C. W. motor. This apparatus is housed in an adjoining smaller building, along with a 12 x 12-inch air compressor, built by the Norwalk Iron Works, used for the supplying of compressed air to the pneumatic chipping and riveting tools, hoist, drills and sand shakers. The compressor is driven by an overhead 45 horse power C. W. compound motor and is capable of delivering 256 cubic feet of free air per minute under a pressure of 80 pounds per square inch. An ingenious disposition has been made of the old 80 horse power boiler, formerly used to furnish steam to a steam-driven air compressor, by now utilizing it as an air storage tank to steady the fluctuating demands upon the compressor.

The fitting shop contains a variety of tools, of which the following data concerning motor equipment may be of interest, especially with reference to sizes of motors used.

The punches and shears, which may be used interchangeably, for one purpose or the other, by substituting the proper tools, are of Long & Allstatter make and are driven through two trains of gears by Crocker-Wheeler motors. The largest, shown in Fig. 2 accompanying is a No. 00, capable of shearing a 6 x 6 x 1½-inch angle-iron, and is driven at 24 strokes per minute by a 7½ horse power motor running at 1,000 revolutions per minute. A No. 4 punch is driven by a 3 horse power motor reducing in speed from 1,050 revolutions to 32 strokes per minute. A No. 0 and a No. 1 shear are each driven at 24 strokes per minute by a 5 horse power motor running at 1,065 revolutions. A special lathe for facing off the ends of columns is belt-driven with two speed reductions by a 15 horse power compound motor running at 840 revolutions per minute.

Two drill-presses, illustrated herewith, being of about the same size and usually running simultaneously, are placed back to back and driven from a single belt passing successively over the driving pulleys of each press and the motor. The motor is supported between and above the presses on brackets attached to the press frames. A third smaller drill-press is driven by a 1 horse power motor, and the fourth, with a small emery wheel and a grindstone is driven through a short line shaft by a 3½ horse power motor. A Norton double emery grinder with two 18-inch wheels is driven by a 3 horse power motor at 1,100 revolutions per minute and a Diamond Machine Company's face-grinder with a 14-inch wheel and a 36-inch stroke of bed, operates from a 5 horse power motor.

The remainder of the fitting shop embraces a cold-saw belt-driven by a 5 horse power shunt motor running at 1,065 revolutions; a New Haven planer with a 10-foot by 30-inch bed, driven by a 6½ horse power compound motor; a Gould & Eberhardt 24-inch shaper belted to a 2 horse power compound motor, and a No. 5 Sturtevant blower for all blacksmith work, delivering 4,500 cubic feet of air per minute when driven at 1,090 revolutions per minute by a 4 horse power motor.

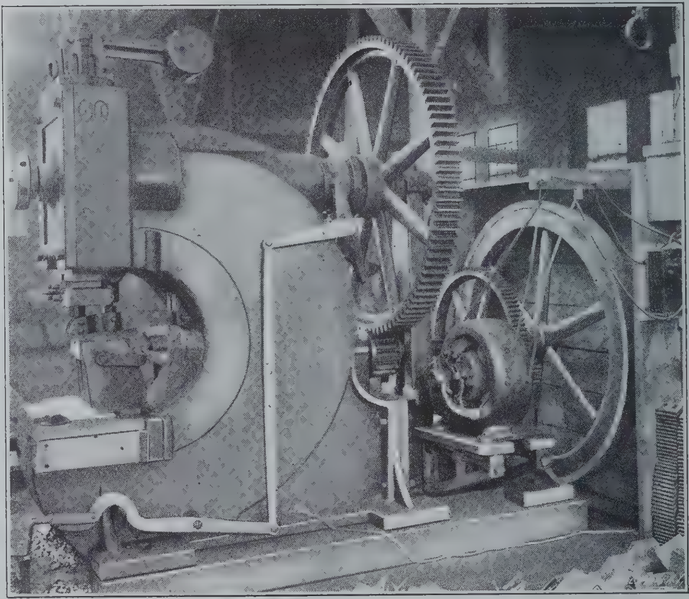

Fig. 2. Motor Attachment for Punch and Shear.

In the pattern shop individual drives are also employed. The buzz-saw is driven by a 5 horse power motor. A semi-inclosed type of motor is used for this on account of its heating less at high speed, and as it was necessary to prevent the saw-dust carried back by the belt from eventually finding its way into the working parts of the motor, a fan was placed on the end of the motor shaft with the blades bent so as to blow the dust away from the motor.

* * *

The high price paid by the United States Government for armor plate, affords a large profit to the manufacturers, no doubt, but then it is not all cream. The material used for making armor plate is not a simple carbon steel, casehardened as some would have us believe, but is a steel that is alloyed with nickel and sometimes chromium, both of which are high-priced metals. Nickel has the effect of toughening the steel, and chromium hardens it. The heat treatment is also a complicated process that has to be carefully conducted to secure uniform product, having a hard face and a tough back.

METALLIC PACKINGS.*

THEIR HISTORY AND DIFFERENT FORMS.

The author, Mr. Charles Longstreth, introduces his subject by saying that metallic packings attracted attention at a very early date in the history of the steam engine. Edmund Cartwright's patent of 1797, No. 2,202, specifies the following: "The piston rod is also packed upon the same principle, that is to say, solely with metal which is thus done: The top of the cylinder being made true and smooth, a flat ring, cut into segments, lies upon it and embraces the piston rod, toward which it is pressed inward by springs; this ring is inclosed by another, divided into segments, and to which it is pressed inward by springs. The segments of the inner and outer ring must be so placed as to break joint. The rings are covered by a third, which is held down by any adequate pressure, as in the piston; the whole may be encircled by a box for holding oil, etc." This covers the principal points of quite a number of the well-known packings of the segmental block type in use at the present time.

Also Richard Trevithick's patent of 1815, No. 3,922, particularly alluded to a combination of fibrous and metallic packings. He also describes a design that is practically the basic principle of the present double packings, that is, two stuffing boxes with intervening space. At that early date he was impressed with the friction caused by the fibrous packings, and used his double packing with the idea that he could overcome some of this friction by allowing steam or water to occupy the space between the two packings.

John Barton's patent of 1816, No. 4,062, and drawings which accompany it, plainly show a very ingenious segmental block packing, which would probably be considered a good one even at the present day.

The purposes of a piston-rod or valve-stem packing are to prevent leakages of steam both along the rod or stem, and also between and around the packing, and to do this with minimum pressure and friction. At the same time the packing should not be designed to act as a guide for the rod or stem, thus partly usurping the function of the crosshead guide. The packing, on the contrary, should be designed so that it will be sufficiently flexible to follow slight lateral movement of the rod while remaining steam tight. It is to the realization of this latter requisite that the more recent designs of metallic packings owe their superiority over the old-fashioned fibrous or the early designs of metallic packing.

The character of the rods to be packed must be considered in the design of metallic packing. If the moving parts require no guiding, as in the ordinary type of steam pumps, the problem is a comparatively simple one. If the moving part has a slight vibratory as well as a reciprocating motion, then the problem becomes quite difficult to solve. The vibratory motion, being caused by the slight difference in diameter between the piston and cylinder, as well as by the play between crosshead and guide, changes at every point of the stroke and varies with every position of the connecting rod. Slight vibratory motion may also be caused by the roll or pitch of the vessel, in the case of marine engines, and while the amount of such motion may seem trivial to some, it bears a very important relation to the wear of both packings and rods.

In order properly to classify packings to meet the varying conditions to which they are subjected we should divide them into two general classes:

1. Rigid packings of the male and female-ring order.
2. Flexible packings, which can again be subdivided into two types—the segmental or block design and the conical-ring form.

The design of rigid packings is shown in Fig. 1. It prevents the leakage of steam around the stuffing box, by having the outside of the female rings pressed against the stuffing-box wall. In order to prevent the leakage of steam along the rod, the inside of the male rings is pressed toward the rod. The force holding these rings against the various surfaces is exerted by pressing the gland against the end of the rings. As ordinarily designed, the great trouble with such packings is to secure a steamtight joint against the wall of the stuffing box, as there is no wear there. This can only be accomplished by producing great friction and pressure against the rod, and as the packing fills the entire space between the walls of the stuffing box and the rod, it does not allow any of the vibratory motion previously alluded to.

Where vibratory motion exists and this class of packing is used, the packing is compelled to do a large amount of the guiding that should be taken up by the walls of the cylinder and the guides. The absurdity of attempting to do this part of the work with a surface so small and a material so soft as that of the packing will be at once apparent to the engineer.

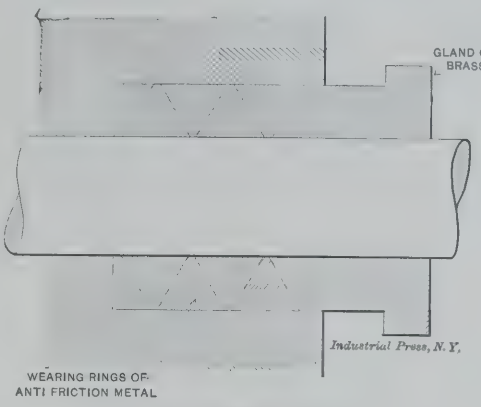

Fig. 1 Rigid Packing.

It can readily be seen why piston rods fitted with this type of packing require such an excessive amount of lubrication to prevent the rods from running hot. Frequently, with packings of this type, rods become so hot as to melt the anti-friction metal and cause it to run from the stuffing box. This packing, therefore, can only be used with success on valve stems and rods of auxiliaries, as well as on the appurtenances to boilers and engines, and wherever the motion of the rod or stem is comparatively small and infrequent. Packings of this design are of very early origin, the first of them being used about 1843.

The flexible types of packings, which may be considered as designed on engineering principles, differ entirely from the foregoing. The new designs do not attempt to fill the entire stuffing box, as steam is allowed to enter the stuffing box and the packings thus have a chance freely to acquire a vibratory motion. The steam leakage around the walls of the stuffing box is duly taken care of by metal or other gaskets under glands, and by sliding faces ground steamtight. The gland is thus pulled up tightly against the intervening joint and the cylinder head, and all the adjustment takes place from the inside.

The segmental ring or block form of flexible packing is shown in Fig. 2. These packings are usually metallic segments, although it is often the case that they are simply blocks of metal held fairly close to the rod by some form of pressure—that is, either by means of a spring, by the pressure exerted by the steam, or by a combination of both these forces.

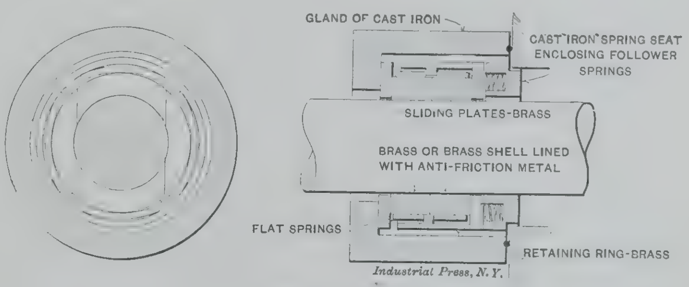
GLAND OF CAST IRON
CAST IRON SPRING SEAT ENCLOSING FOLLOWER SPRINGS
SLIDING PLATES-BRASS
BRASS OR BRASS SHELL LINED WITH ANTI-FRICTION METAL
FLAT SPRINGS
RETAINING RING-BRASS
Industrial Press, N. Y.

Fig. 2. Segmental Ring Packing.

There are probably more different designs of this class of packing than of any other, since such forms may be designed by people of comparatively little experience, and give fairly good satisfaction where moderate steam pressures are used.

Those in charge of marine machinery should be impressed with the fact that the quality of the steam supplied to the engines will have a very important influence upon the life of the packing. There is no doubt but that even a slight amount of water in suspension in the steam brings with it from the boiler some gritty substance. While this amount may be apparently of an inconsiderable nature, it is sufficient to greatly increase the wear of metallic packings. The relative life of metallic packing when using both dry and wet steam was evidenced in the case of sister ships belonging to the same line, running on the same service and carrying the same pressures. On the high-pressure rod of one ship, where no care was taken to secure dry steam, the life of the packing averaged thirty days' wear. On the engines of the sister ship, where care was taken to secure dry steam, the same packing has been in use for several years.

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* Abstract of an article in the Journal of the American Society of Naval Engineers for May, 1903.

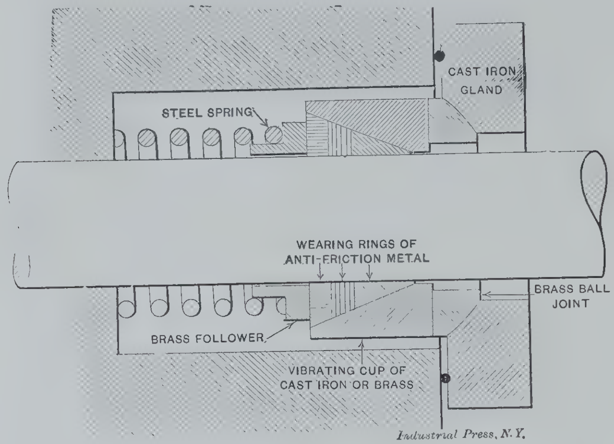

Fig. 3. Conical Ring Packing.

The principal objection to segmental packings is that they are expensive to manufacture and necessitate care in maintenance. They are generally of a complicated nature, since they comprise a large number of springs, segments and rings. As the packing is forced to the rod by the steam pressure, the friction on the rod or stem increases proportionally with increase in boiler pressures. In other words, it is almost impossible to use packings of this character on a triple-expansion engine and obtain anywhere near the same length of wear from the packings for the three different cylinders; the high wearing out most rapidly, the intermediate wearing out next rapidly, and the low lasting the longest.

The last type of packing to be considered is usually known as the conical ring, and is shown in Fig. 3. This type of packing has given better satisfaction under adverse conditions than all others, and is the packing used on 90 per cent of the locomotives running in the United States. This in itself is an evidence of its ability to run under adverse conditions with little repair.

The principle of this packing is that conical, soft-metal rings are pressed against the rod, and thus packing is accomplished by the rings being forced into a solid cup bored to conform to the outside of the rings. These rings are pressed into the cup partly by a spring, but principally by the steam itself. If the pressure of steam was constantly on the packing the springs would be unnecessary, as they are used merely to hold the packing in place while steam is shut off the engine.

In order that this packing shall be satisfactory, the cup must not be allowed to touch the wall of the stuffing box at any time. The proper design as well as the character of material of these packings is therefore the most difficult problem to be solved in the packing business, as the mixture of metal in the rings, as well as the form of the outside of the rings, must be such that the packings will merely prevent the leakage of steam and not cause excessive friction.

Where properly designed, these packings can be made to give approximately the same length of wear on all the rods of a multiple-expansion engine. However, in practice it has been found that this is not entirely desirable, and so, when usually designed by first-class manufacturers, the high-pressure packings wear out a little while before the intermediates and low.

It will often be noticed that the shape of rings in packings of this character on the high-pressure rods is slightly different from that on the intermediate and low. In order to permit cheap and rapid repairs, it is desirable to have a uniform quality of metal used for the rings, while it is also necessary to have the form of rings balance differences in pressure.

With this type of packing there is absolutely nothing that comes in contact with the rod except the white-metal rings. The glands, neck bushings, cups, followers, etc., are bored considerably larger than the diameter of the rod or stem, and as the rings are made of soft metal and properly designed, they will cause very little friction and wear on rods.

Many experiments and tests have lately been made with packings of this nature, and where proper provisions are made to allow the rings and their inclosing cups to move freely with the rod, they have been universally satisfactory. In order to allow the cup completely to accommodate itself to this condition, it is advisable to provide a ball joint in addition to the sliding face previously alluded to. A hot rod from packings of this type is practically unknown, and in railway service, where at the present time all details of this kind are apt to be carelessly handled, that they operate with any degree of success at all speaks volumes for their design. In addition to the above, the advantages of this type are that wearing parts are inexpensive and easy to replace.

The disadvantage of these packings, if it can be called a disadvantage, is that they will not work properly on a rod unless the rod is cylindrical. When packings are applied, if the rod is cylindrical, even though it is grooved, these packings in a short time will become steamtight. There are many cases on record of extremely long service without renewals of this class of packing. Cases are on record of ten years' run, although the average life may be taken as from two to five years, and then the packings may be put in as good condition as they were when new, by merely supplying a few inexpensive soft-metal rings.

It is remarkable how little attention has been paid to this engineering subject and the ignorance of proper principles upon the part of engineers. It really requires very little cross-section of rings to do this work of packing, provided everything is properly designed; and the old notion, that the more rings and the deeper the stuffing box the better the packing, should be discarded as entirely wrong. If the packing manufacturer were consulted at the time engines were designed, it would often be possible on the ordinary marine engine to lower the cylinders from six to eight inches, and keep the other proportions of the engine exactly the same. From this can be readily seen the importance of this subject. Think of the weight of metal saved in six inches of housings, piston rods, valve stems, etc.

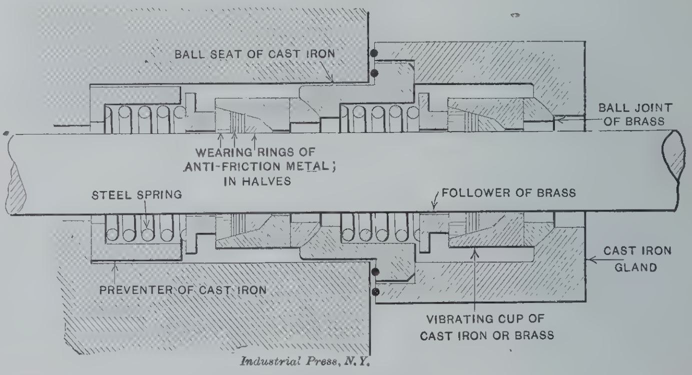

Fig. 4. Double Packing for Marine Work.

In practice, for most stationary and marine engine work, double packing is used, as shown Fig. 4, that is, practically two stuffing boxes, the packing nearest the cylinder doing all, or nearly all, of the real work. The lower packing does little or no work until the upper packing is worn out or fails or leaks, when the lower packing catches this leakage or takes up the work in case of failure.

* * *

Does steel improve by age, or, in other words, will a bar of steel that has stood in the warehouse a long time make a better tool than one fresh from the hammers or rolls? Some persons think it does improve, and there are those who buy their steel ahead of requirements so as to season it as lumber is seasoned.—*Sparks from the Anvil.*

THE EVOLUTION OF THE CHANGE GEAR.—3.

OSCAR E. PERRIGO.

Again in Patent No. 684,433, also dated October 15, 1901, Herman R. Isler tries his hand at the change gear problem, this time adapting the plan of a disk of gears. These two applications for patents followed each other at intervals of about two and a half months. This device is much more simple than his former effort and is arranged on the popular eccentric plan first shown by Burdick in 1895. The pinions of the disk of gears are operated by sliding keys. In the drawing Fig. 1 is an end elevation of the device, and Fig. 2, is a vertical, longitudinal section. Power is transmitted from the head spindle by the gears *a*, *b*, *c*, *d*, and *e*, the latter four being arranged in two pairs, *d*, and *e*, being brought into action by means of a sliding key, operated by the knob *h*, thus giving the shaft *H*, two changes of speed. Gear, *i*, is splined on the shaft *H*, and engages the internal gear *k*. Formed on the outside of the internal gear *k*, is the gear *l*, which is adapted to engage a series of gears *f*, *g*, etc., of varying sizes disposed around it as shown in Fig. 1. These gears are in pairs, one of which is adapted to engage the external gear *l*, and the other to engage the idle gear *m*, to which is attached the gear *n*, engaging the gear *o*. Upon the next stud are the gears *p*, *q*, engaging similar gears *r*, *s*, on the lead screw *L*, the latter being brought into individual action by the sliding key controlled by the knob *t*. The revolving disk *G*, carrying the series of gears *f*, *g*, etc., is held in place in any desired position by the spring pin *v*.

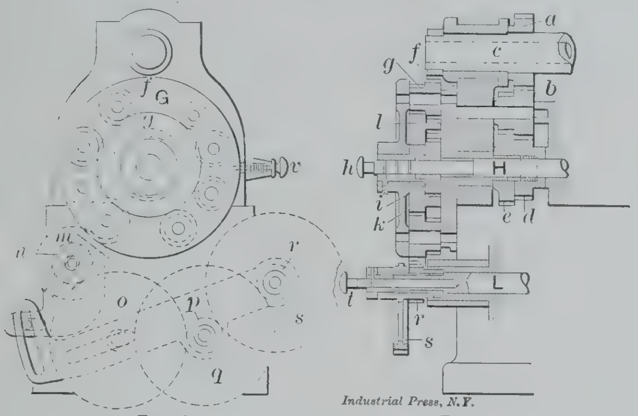

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Fig. 1 Fig. 2

Herman R. Isler. No. 684,433, Oct. 15, 1901.

Once more Herman R. Isler attempts to solve the change gear idea, in Patent No. 704,645, dated July 15, 1902. He adheres to the "disk of gears" form and improves on his previous device, retaining the eccentric method of mounting and adding a supplementary arrangement for multiplying the speeds obtained by the pinions in the disk. The former are still controlled by sliding keys. In the drawing, Fig. 1 is an end elevation, and Fig. 2 a front elevation of the device, the series of gears of the disks being represented by dotted circles. Power is conveyed from the head spindle in the same manner as in his last patent, and the gears of the first disk *A*, are arranged in the same manner. But instead of the final gear driving direct to the lead screw, it conveys motion by means of idle gear, *b*, to a second disk of gears *B*, arranged substantially in the same manner and designed to still further multiply the possible changes of speed at which the lead screw *L*, may be driven. The knobs, *a*, *c*, *d*, *e*, *f*, are adopted to effect the various changes by throwing into and out of engagement a series of clutches connecting the required gears and disconnecting those not needed. One disk or case full of revolving gears, most of which would probably be ruined by the breaking of a single tooth in any one of the numerous gears, is bad enough, but when another box of "gear trouble" is added it would look like hunting for difficulties that are apt to come fast enough at best.

Richard K. LeBlond, of Cincinnati, Ohio, shows us in his Patent No. 706,186, dated August 5, 1902, a practical and very mechanical method of obtaining a large variety of feeds and threads pitches by the combination of three cones of small gears, and the necessary sliding gears for connecting either the lead screw or the feed rod, the whole being operated by two handles and a knob. The arrangement of shafts, gears, and yokes is very compact and is principally within the lathe bed. One peculiarity of this arrangement is that the yokes or "travelers" carry not only connecting gears but cones of gears. This is also seen in the device of Peter and William Shellenback in 1892. In the drawing, Fig. 1 is an end elevation of the device, and Fig. 2 is a development, in section, of the train of gears from the regular connecting gears from the head spindle to the lead screw and feed rod. The path of the transmission of power, is from the head spindle gear, *a*, to *b*, and *c*, upon the shaft *d′*, on which slides the traveler *D*, carrying the pinion *d*, and in whose forked end are journaled the gears *e*, *f*, *g*, on the shaft *g′*, adapted to engage as desired the gears *h*, *i*, *k*, on the shaft *h′*. The gear *i*, engages the gear *l*, of the cone of gears l, l^1, l^2, l^3, etc., mounted on the shaft *x*, journaled on the sliding lever *M*, which also carries the connecting pinion *m*. By proper manipulation of the lever *M*, the gear *l*, may be made to engage either of the gears *h*, *i*, *k*, and also any gear of the cone of gears l, l^1, l^2, l^3, etc., may engage the gear *k*, thus producing a large number of changes. Upon the shaft *y*, is fixed the gear *n*, which may by means of the knob *z* be brought into engagement with the gear *p*, on the lead screw *L*, or the gear *o*, on the feed rod *R*. The levers *D*, and *M*, are operated and held in any desired position in the usual manner, as shown in Fig. 1.

It is evident that when William T. S. Johnson, of Cincinnati, Ohio, set out to devise the arrangement for which he obtained Patent No. 706,665, dated August 12, 1902, he was determined to produce something that would at least be novel, whatever other claim it might have to interest mechanical men. In this case the oft-recurring cone of gears is placed upon a sleeve journaled directly upon the head spindle of the lathe in place of the usual head cone for driving the lathe, and providing only one large pulley for that purpose. The well-known system of a traveling pinion is used on a supplementary shaft, upon the end of which are placed two gears which, in connection with two others on a stud, form the usual combination for multiplying the changes by two. In the drawings, Fig. 1 is an end elevation, and Fig. 2 is a front elevation and partial vertical section. The usual back gears are of modified construction as seen in Fig. 2, the face gear *b*, being fixed to the head spindle and the disk *a*, used as a means of connection between it and the single driving pulley *c*, the connection being by spring pins, as shown. The cone of gears, d, d^1, d^2, d^3, etc., is mounted and fixed upon a sleeve *e*. Sliding upon the supplementary shaft *f*, is the lever *g*, carrying the connecting pinion *h*, through which power is transmitted to the gears *i*, *k*, and thence to similar intermeshing gears *l*, *m*, to the gear *n*, on the lead screw *L*. Either gear *i* or *k* may be connected to the shaft *f*, as desired, by means of a sliding key operated by the knob *p*. Thus, while the number of speeds of the head spindle is very much reduced, (unless some form of variable speed countershaft, or an easily controlled electric motor is used),

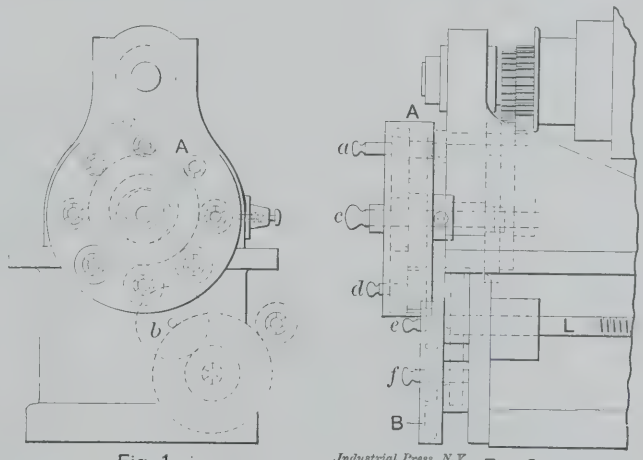

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Fig. 1 Fig. 2

Herman R. Isler. No. 704,645, July 15, 1902.

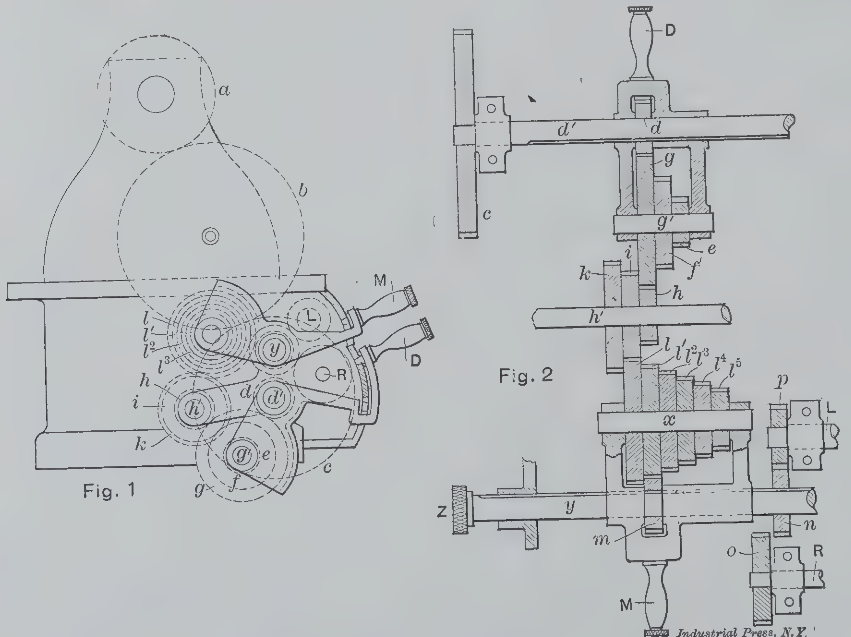
the number of speeds of the lead screw is very easily obtained. Yet the sacrifice of the usual five-step driving cone would not seem to commend itself to practical mechanics.

Having now described in detail the various patents up to a quite recent date, comparing them with each other, and having traced as clearly as may be the evolution of the change gear, it seems proper to offer some observations in the form of a summary of what has been presented.

The predominating features of all these various methods of producing a variable feed or a number of pitches of thread cutting, is the use of the "cone of gears," or a collection of gears arranged on a shaft "in step-like form." The second feature is that of providing, in connection with the cone of gears, two or more pairs of gears, which may be termed multiplying gears, each two pairs multiplying by two the number of changes produced by the cone of gears, or dividing in the same ratio the speeds already attained. By multiplying gears is meant, pairs of small gears, usually a larger and a smaller on each of two shafts, say of 24 and 48 teeth, which may multiply or divide the speed by two. These may be used with gears of equal size, for instance with the above numbers of 24 and 48 teeth the equal gears may each have 36 teeth. When used in connection with the cone of gears, they multiply the changes given thereby, as for instance, if the cone is of seven gears, the number of changes is readily made fourteen, twenty-one or twenty-eight.

A radical departure from these methods was made, first by Edward Flather, April 2, 1895, and Benj. F. Burdick, April 23, 1895, and later by Wm. L. Shellenback, December 5, 1899, and in another patent, February 5, 1901, and by Herman R. Isler, October 15, 1901, and July 15, 1902. This consisted of arranging the series of various sized change gears on a circular disk, and usually around a central gear from which any one of them was operated, or by which the motion was communicated to the lead screw. In the later patents they are arranged in an eccentric form so that only the pair needed at the time will be in action. It is doubtful, however, if either of these devices will come into general use, owing to the large number of parts, the complication and expense which they involve, as well as the difficulty of operating them by the average grade of machinists who might be called upon to use them, and the danger of breaking the gear teeth.

The one inventor who departed from all the usual forms on which others had seemingly rung all possible changes was Carl J. Paulson, June 18, 1895, who adopted a series of toothed rings, one within the other, which are engaged by a swinging pinion when any desired ring is moved out to its active position.



Richard K. Le Blond. No. 706,186, Aug. 5, 1902.

It is a somewhat remarkable fact that with the exception of the first claim of Bancroft and Sellers, 1854, all the claims in the twenty-seven patents herein discussed, are what is known as "combination claims," and that in all the two hundred and thirteen claims in this series of patents the devices and arrangements are often so near a counterpart of some prior patent that the delicate points of decision upon them in the Patent Office must have been a hair-splitting process, governed more by the exact and carefully worded phraseology of the claims than the difference in the ideas of the inventors from those of former patents. Bancroft's claim, referred to above, is this: "The method of varying the motions of the mandrel (head spindle), and screw shaft, or leader, by means of two series of wheels, each series consisting of wheels of different diameters, and all the wheels of one series being connected and turning together, and imparting motion to all the wheels of the other series with different degrees of velocity, substantially as described." Inventors have been harping on that same string ever since. It may be truly said that Edward Bancroft and William Sellers are the originators of the method of producing variable feeds for turning or thread cutting in a lathe by the use of the "cone of gears." In these articles there have been twenty-seven patents considered, comprising all relating to this subject on file in the United States Patent Office up to August 12, 1902. The following is the entire list.

Edw. Bancroft-Wm. Sellers	No. 10,491,	February 7, 1854.
John Humphreys	No. 83,774,	November 3, 1868.
Frederick B. Miles	No. 111,859,	February 14, 1871.
William Bley	No. 156,758,	November 10, 1874.
Charles W. Riley	No. 233,702,	October 26, 1880.
Andrew Hyde	No. 247,764,	October 4, 1881.
George A. Gray, Jr.	No. 252,760,	January 24, 1882.
Joseph Flather	No. 462,481,	November 3, 1891.
Peter & William Shellenback	No. 468,183,	February 2, 1892.
Wendel P. Norton	No. 470,591,	March 8, 1892.
William Shellenback	No. 518,164,	April 10, 1894.
Wendel P. Norton	No. 519,924,	May 15, 1894.
Salmon W. Putnam	No. 525,863,	September 11, 1894.
Edward Flather	No. 536,615,	April 2, 1895.
Benjamin F. Burdick	No. 537,816,	April 23, 1895.
Carl J. Paulson	No. 541,385,	June 18, 1895.
Herbert L. Flather	No. 592,966,	November 2, 1897.
Ernest J. Flather	No. 595,562,	December 14, 1897.
Benjamin A. Wheeler	No. 602,924,	April 26, 1898.
William L. Shellenback	No. 638,359,	December 5, 1899.
William L. Shellenback	No. 667,406,	February 5, 1901.
Edward A. Muller	No. 679,568,	July 30, 1901.
Herman R. Isler	No. 684,432,	October 15, 1901.
Herman R. Isler	No. 684,433,	October 15, 1901
Herman R. Isler	No. 704,645,	July 15, 1902.
Richard K. LeBlond	No. 706,186,	August 5, 1902.
William T. S. Johnson	No. 706,665,	August 12, 1902.

Of the twenty-seven inventions, fifteen, viz.: Bancroft and Sellers, Humphreys, Miles, Riley, Hyde, J. Flather, P. and W. Shellenback, Norton, W. Shellenback, H. L. Flather, E. J. Flather, Wheeler, Isler, LeBlond, and Johnson, make use of the "cone of gears" in various positions and methods of operation.

Of the fifteen inventors who use the cone of gears there are nine, viz.: Humphreys, Miles, Hyde, Norton, H. L. Flather, E. J. Flather, Wheeler, LeBlond, and Johnson, who use the "traveler" and its connecting pinion to operate the intermediate shaft at its variable speeds.

As to the location of the cone of gears, Humphreys and Johnson put it in the head; Bancroft and Sellers, Miles, Riley, and Hyde, place it at the end of the head. P. and W. Shellenback, H. L. Flather, E. J. Flather, Isler, and LeBlond locate it in the bed; E. J. Flather forming a space in the front of the bed for that purpose. Norton puts the cone of gears in front of the bed, Wheeler puts two cones of gears at the end of the bed and one in the apron. Isler puts two cones of gears in the bed and four at the back of the bed.

Of the methods of operating the cones of gears, ten of the inventors fix the cone of gears on the shaft. Bancroft and Sellers have one cone loose on the shaft and connected by a removable pin, while the other cone is fast to the shaft. Riley, J. Flather, Wheeler, and Isler, use sliding keys. Johnson fixes his cones of gears on a sleeve, loose on the head spindle, while P. and W. Shellenback have their cone of gears slide on the shaft in order to bring the gears successively into engagement with the connecting pinion. Isler uses no less than six cones of gears, while Wheeler uses three.

In the twenty-seven patents there are two hundred and thirteen claims, Wheeler leading the number with thirty claims. P. and W. Shellenback have twenty-one. W. L. Shellenback has seventeen. Putnam and W. L. Shellenback (1901) each have fifteen claims. Miles is the most modest in his pretensions, making only one claim, while adding quite as much to the then "state of the art" as some of his later competitors. Wheeler easily "takes the cake" in his specification and claims, its seven printed pages rivalling a Ralph Waldo Emerson lecture.

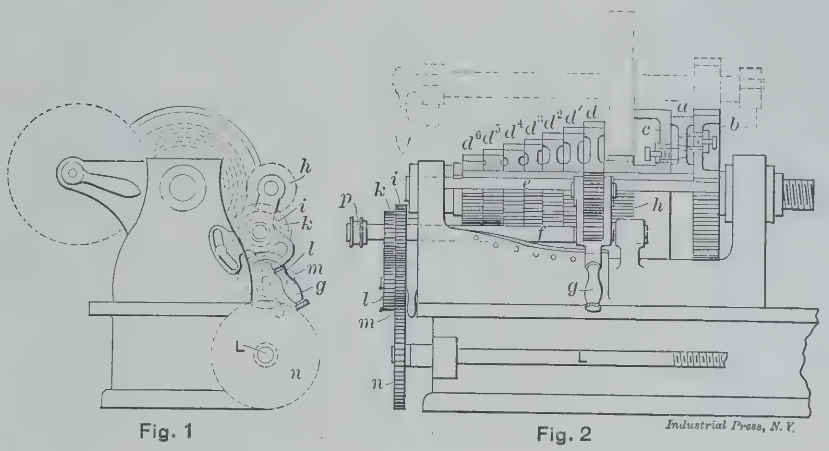


Fig. 1 Fig. 2

Industrial Press, N.Y.

William T. S. Johnson. No. 706,665, Aug. 12, 1902.

The examination of all the mass of Patents, amounting to one hundred and fifty-six, the selection of those particularly relating to the change gear devices, and the efforts to reduce them to their mechanical requisites have been a long and tedious work. That it is not perfect no one knows better than the author. That it may be of some assistance to conscientious investigators of the important mechanical devices of which it treats is the earnest wish of the writer of these articles.

* * *

The Pedrick & Ayer Co., who for many years have been located in Philadelphia, have now completed new works at Plainfield, N. J., to which point the business has been removed. The plant consists of a main shop 100 by 400 feet, boiler house, engine house, blacksmith shop and pattern storage building.

The main building contains the offices of the company, drafting room, tool room, and storage of principal raw materials and finished parts. The principal portion, however, is taken up by the machine shop proper, the fitting, assembling testing and shipping departments.

The main bay is provided with a 15-ton Shaw electric crane and there are numerous hoists and jib cranes actuated by compressed air. The machine tools are all driven by electric motors, the prevailing plan being to group several machine tools on one motor-driven countershaft. In the testing department arrangements are made to provide practical working conditions for the air compressors, riveters, hoists and cranes, which they manufacture.

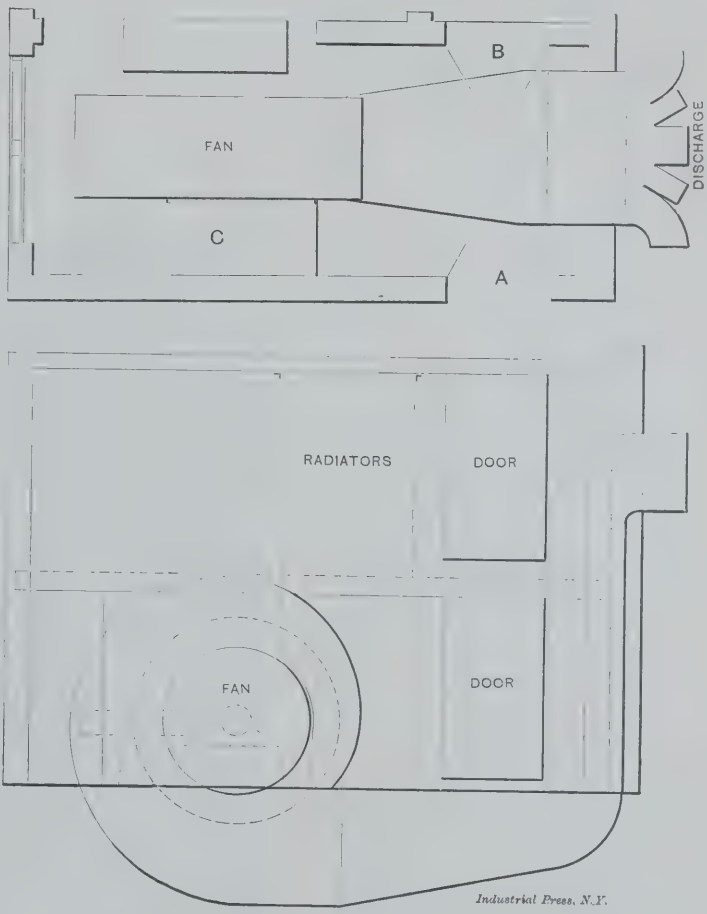
The boiler and engine house, with fire wall and metal door between, might be considered as one building. The engine room contains a belted automatic air compressor of the type largely sold by the company and two direct-connected dynamo-engine sets for supplying power and light to the entire works. The sets are 150 kilowatts capacity each, the engines furnished by the Ames Iron Works and dynamos and switchboards by the General Electric Company.

* * *

In a recent consular report the United States commercial agent at Eibenstock, Germany, mentions a large electric crane that has recently been erected in the harbor of Kiel for loading and unloading vessels. It is of the weighted cantilever type, mounted on a structural steel column which gives head room of fully 75 feet under the arm. The capacity is fifty tons.

THE NEW FOUNDRY OF THE BROWN & SHARPE MFG. CO.—2.

In the general description of the Brown and Sharpe Mfg. Co.'s foundry in the last number, brief reference was made to the hot-blast heating system installed by the B. F. Sturtevant Company. There are two heating units, one for the heavy foundry and one for the light foundry, casting cleaning and storage departments, offices, etc. The apparatus for the heavy foundry is in accordance with the most recent ideas on the heating of large buildings and is of sufficient interest to call for special mention. It used to be considered necessary in warming large areas to deliver highly heated air at many different points in order to bring the whole to a uniform temperature. Long sheet-metal distributing pipes suspended near the ceiling, with openings at frequent intervals, were invariably used for this purpose and of course are necessary where there are numerous departments to be heated or the single room or building is of unusual dimensions. If the conditions are right, however, air can be thoroughly distributed without this expedient, and in the case of the heavy foundry of this plant, a building 95 by 160 feet, there are no pipes used. The heated air is delivered at a central point on one side of the building, through a duct having mouthpieces aiming toward different parts of the foundry to diffuse the air as much as possible. The air is delivered in large volume, moderately heated, and consequently is not likely to produce drafts disagreeable or dangerous to the workmen. The heated air comes in contact with the walls and roof where it is cooled somewhat, which causes the current to move toward the floor, warming the lower part of the space.



Industrial Press, N.Y.

Fig. 1. Diagram of Heating Unit for Heavy Foundry.

In Fig. 1 is an outline plan and elevation showing the fan and duct leading to the foundry. The duct enters at a central point on one side at about 12 feet from the floor and has five short discharge pipes pointing in different directions, as represented in the plan view in Fig. 1. The fan is located in a bricked enclosure with an intermediate floor, on which the radiator coils are placed. Below, on the first floor, is the fan with discharge duct underneath which leads to the vertical pipe and thence to the openings into the foundry. There are doors, *A* and *B*, in the sides of the enclosure, the two lower doors giving access to the fan and the two upper ones. air admission to the radiators. One of the upper doors opens to the interior of the foundry buildings and the other to a light well. The fan draws its supply of air through the duct *C*, from the compartment containing the radiators.

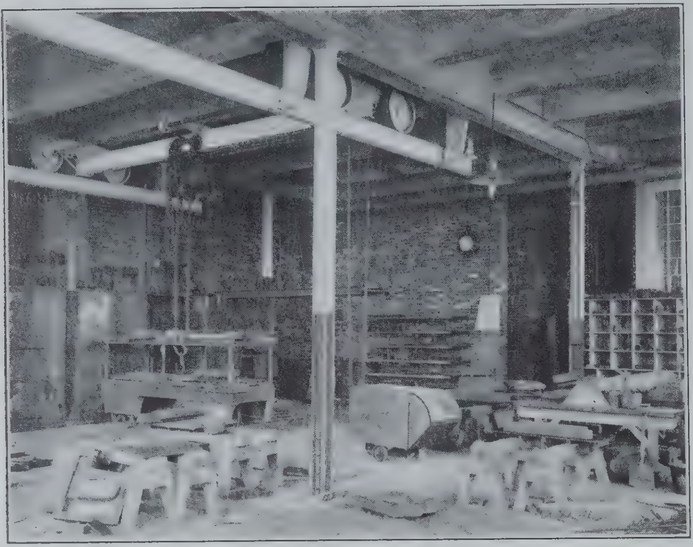
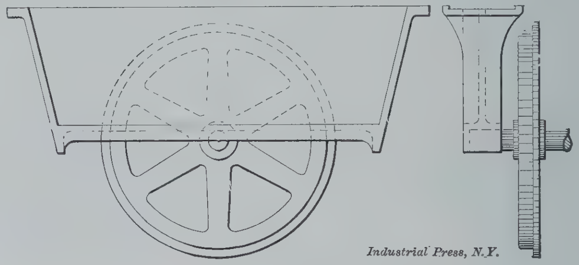


Fig. 2. View in Core Room.

The westerly end of what is known as the "cupola building" is fitted up as the core room of the foundry and is equipped with four core ovens, with ample room for several others, foundations for which are already in. The core room adjoins the heavy foundry and when the light foundry has been extended further to the west, as will be done later, the core room will lie between the heavy and light foundry, just as does the cupola room at the present time. To facilitate the delivery of cores to the heavy foundry and at the same time provide for a core room entirely apart from the foundry proper, the core ovens are so situated that they form the separating wall between the heavy foundry and the core room. The ovens for the larger cores are made with doors at both ends. This enables the core-oven cars to be wheeled into or out of the ovens either from the core room or from the foundry, as required, and cores may thus be placed on the cars in the core room, pushed into the oven to bake, and then pulled out through the other door into the foundry for delivery.

In the full-page engraving on the opposite page are shown details of construction of one of the two larger ovens. Extending in front of all the ovens is a large pit about seven feet deep, giving convenient access to the furnaces below. The pit is covered with an iron grating. In the two upper views in Fig. 5 this pit is indicated and the general arrangement of the furnaces is clearly represented. The lower of these two views and the group of smaller ones at the bottom of the page are sectional views taken along the various lines lettered to correspond in the upper view. A study of the different sectional views will give a clear idea of the details of design of these ovens. The section on *HH* is a longitudinal section through the furnace and shows also a horizontal flue leading from the furnace back to another horizontal flue at right angles to it, which latter connects with two short uptakes that convey the heat and gases to the core oven. The section on *EE*, in the lower right-hand corner, shows the two uptakes and the flue leading to them.

To carry the gases away from the ovens there are two channels in the floor, one on each side, which connect with a channel in the rear leading to the stack. These channels are covered by iron plates, and by removing one or more of them the size of outlet of the stack is readily controlled. This plan of two channels, one on each side of the oven, ensures very even distribution of heat in all parts of the oven and the manner of adjusting the openings to them gives absolute control over the oven temperature. At the top of the ovens are dampers opening directly to the stack. (Fig. 6.) These allow the gases to pass off when the oven doors are open and also ensure a direct draft when starting up the fires. In practice, however, it is found necessary to use the dampers but little.



Industrial Press, N.Y.

Fig. 4. Anti-friction Bearing for Oven Cars.

The cars used in these ovens have the anti-friction "barn-door" type of bearings for their wheels, which have already been described in a previous number of Machinery, and are shown in Fig. 4 herewith. The journals on the ends of the axles simply roll along the flat under surface of the supporting brackets of the car, whenever the latter is moved backward or forward, just as in the familiar "frictionless" arrangement of rolls for sliding doors, which require no oiling.

The oven shown at the right in Fig. 3 is designed to afford ample room for a large number of cores and at the same time provide means for withdrawing or renewing a few or as many of them as desired, without disturbing the whole oven. This oven is modeled after similar ovens used by the Singer Sewing Machine Company, Elizabeth, N. J., and the Walker & Pratt Company, Boston, Mass., but is of improved design and is so novel as to be of general interest.

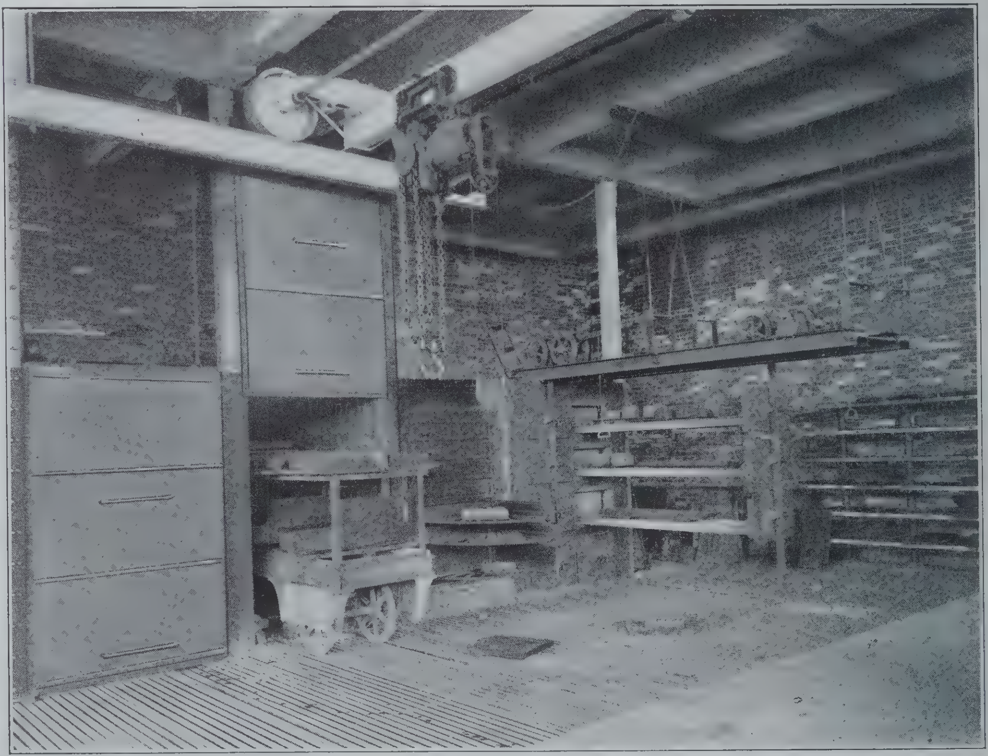


Fig. 3. View of Core Ovens, showing Cars and Racks partially withdrawn.

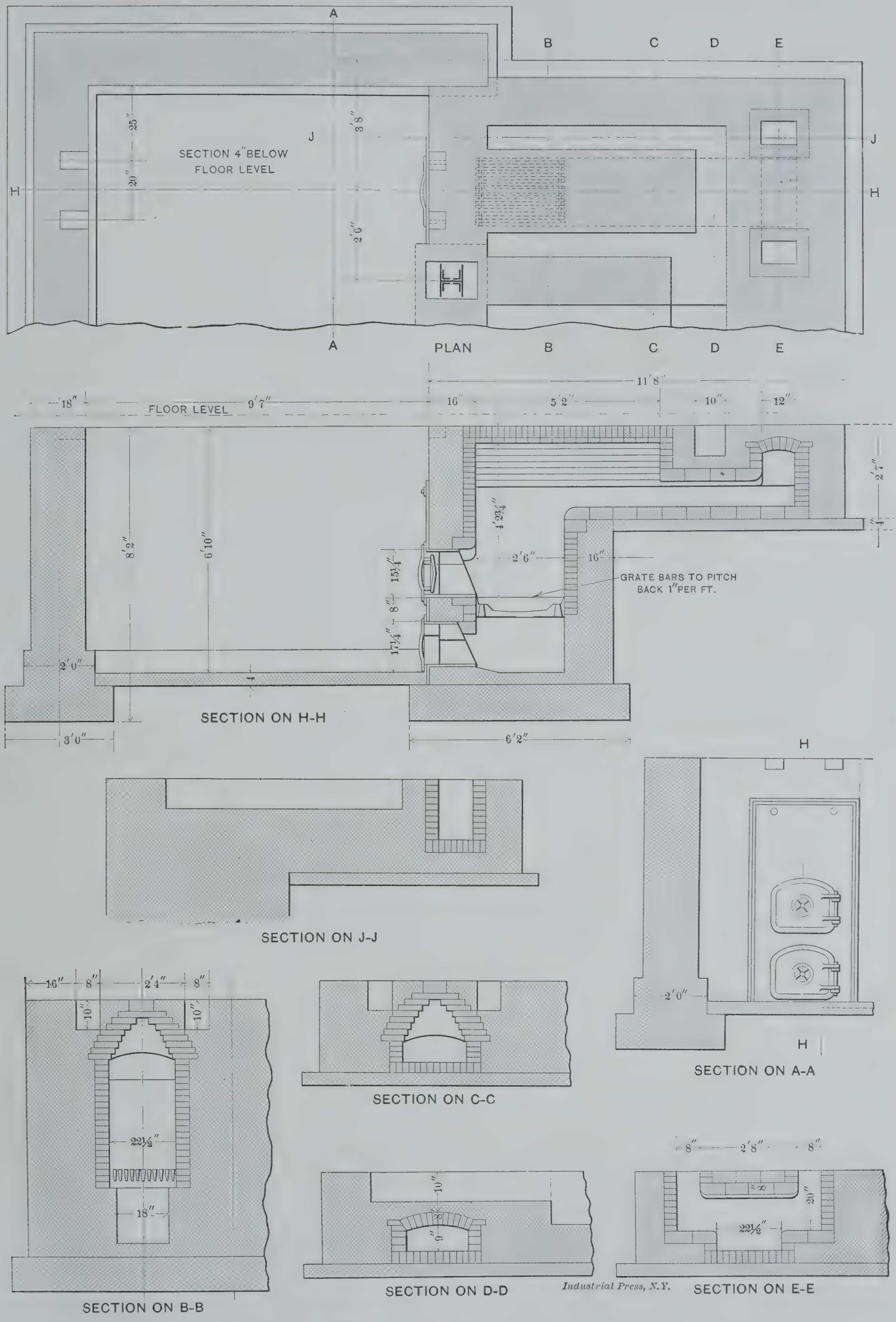


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Fig. 5. Details of Construction of Large Core Ovens.

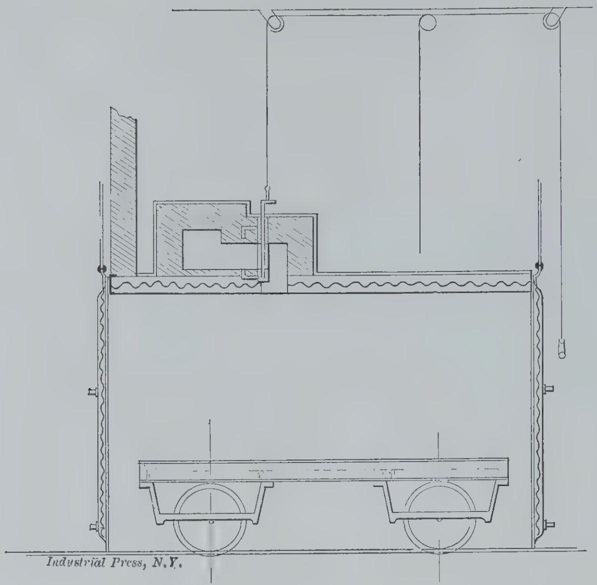

Fig. 6. Showing Damper at top of Oven.

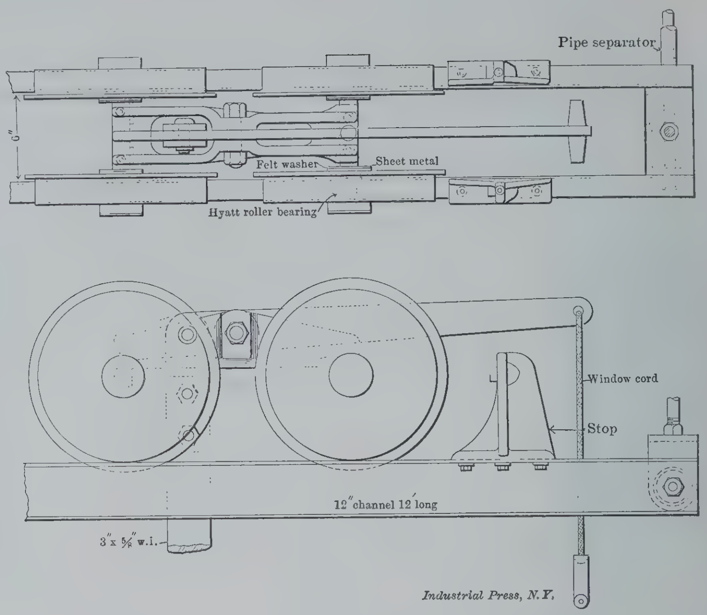

Fig. 8. Trolley used for Supporting Core Racks.

There are eight horizontal movable racks in the ovens, shown clearly in the longitudinal section in Fig. 7. These racks are ranged one above the other, and are supported by wheels and axles so that each rack is virtually the same as a car running on tracks. At the rear of each rack is a pair of wheels running on tracks within the oven, but it would obviously be very inconvenient to have these tracks extend out beyond the front of the oven for the support of wheels on the front of the racks when the latter are withdrawn from the oven. Tracks extended in this way would obviously be very much in the way and would make the oven very inaccessible. To overcome this difficulty and at the same time provide for the support of the forward end of the racks when they are to be withdrawn from the oven, there is an overhead trolley running on an overhead rail, and having a bar extending downward which may be connected to the forward end of any of the racks, enabling it to be rolled out or in. In Fig. 7 the racks *A*, *B*, and *D* are in place in the oven and rack *C* is withdrawn. The trolley supports the forward end of the rack *C*, by means of the rod *R* and a sliding bolt which passes through a hole in the rod and holes in corresponding lugs in the front face of the rack. The bearings at the rear of the racks are the same type of anti-friction bearings used on the cars in the large ovens, and give excellent satisfaction in places where the heat is liable to cause inconvenient expansion or to destroy the lubrication necessary on bearings of the ordinary type.

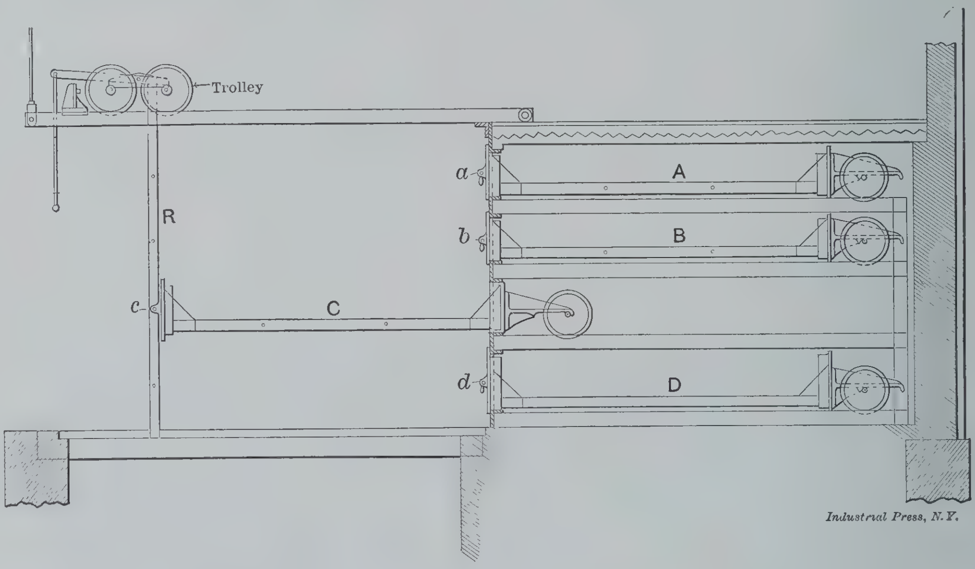

Fig. 7. Section of Oven shown at the Right in Fig. 3.

In Fig. 8 is a detail sketch of the trolley for supporting the

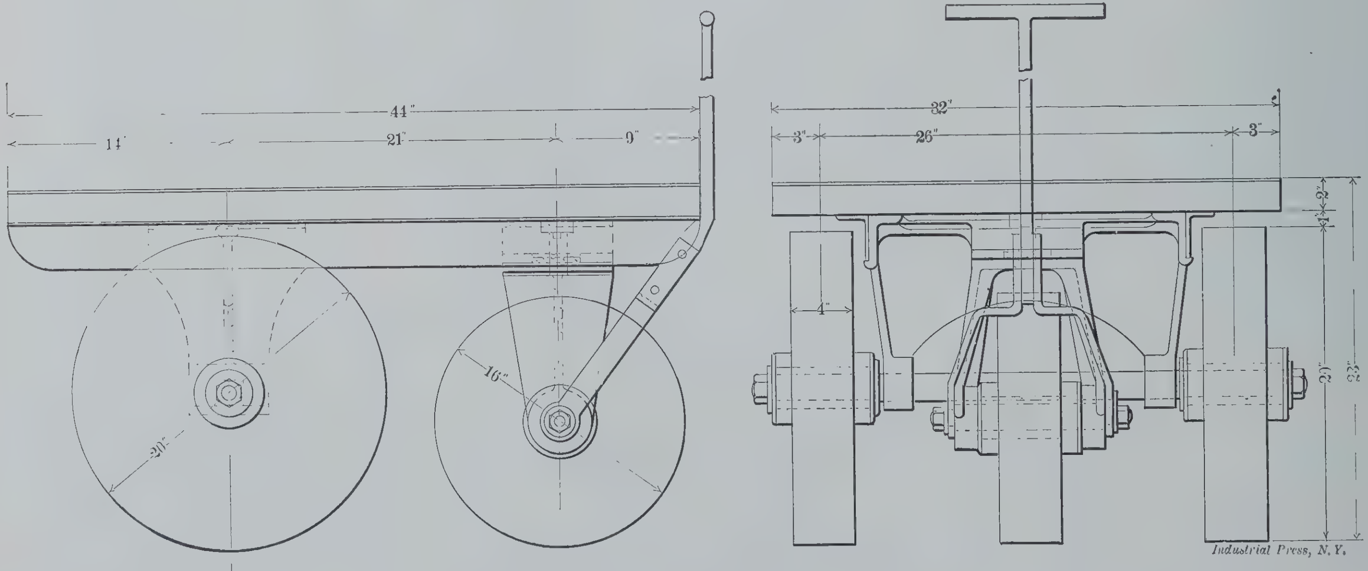

Fig. 9. Charging Car.

forward ends of the racks. The trolley has four wheels, with journals running in roller bearings. The bar by which the racks are suspended is supported by one end of a horizontal lever and by means of which the bar can be raised slightly, through a handle suspended from the long end of the lever. In operation the vertical bar is bolted to the particular rack it is desired to withdraw, and the handle attached to the forward end of the horizontal lever is pulled down. This raises the forward end of the rack from its seat and then by pulling forward on the handle, and on the bar, if necessary, the rack is easily drawn out, and by a similar operation can be rolled back into the oven.

Attention will be called to one other foundry appliance to be found here, represented in Fig. 9. This is the charging truck for the foundry cupolas and similar trucks are also used about the foundry for other purposes. They have frames of rolled shapes and wheels with wide flat treads. The journals have roller bearings and a load of pig or scrap iron is easily pulled into position on the charging floor on one of these. The weight of each truck is marked on the truck in plain figures, so that by weighing the car and charge together and deducting the marked weight of the former, the exact weight of the charge may be determined.

Throughout the foundry dependence is placed on broad iron trackways on which cars of this description can run, rather than on any form of industrial railway. Cars on this system run easily, and can be taken to any part of the works if necessary for loading or unloading, without regard to whether a track runs to that point or not.

* * *

A GERMAN WORM MILLING MACHINE.

ROBERT GRIMSHAW.

The photograph and drawing shown in Figs. 1 and 2 illustrate a machine of German design that is intended for milling simple, double or compound worms and small spiral gears, both right and left hand. In order to mill worms that are made integral with the shaft the spindle of the dividing head is made hollow, allowing the shaft to be passed through so as to bring the worm close to the head. The other end of the shaft is supported by an auxiliary bearing which is also placed close to the worm. On the front of the column is a slide which carries the dividing head and the outboard bearing for the worm arbor, while at the rear of the column on a dovetailed slide is mounted the carriage carrying the cutter. This carriage obtains its motion, when the worm is rotated, by a leadscrew and change gears from the forward feed gear at a rate corresponding to the pitch of the worm. The cutter arbor has its bearing on a swiveling head which, by the aid of a crank, can be adjusted to the angle suitable to the worm pitch. A four step pulley, shown at the left hand side, drives a splined shaft extending the whole length of the machine. From this, by means of beveled gears and a set of spur gears, the general driving motion is conveyed to a shaft lying in the axis of the swiveling plate and from this shaft are driven two worms which simultaneously drive the worm wheel on the cutter arbor. By this arrangement four speeds of the cutter are obtainable, ranging from 15 to 40 revolutions per minute.

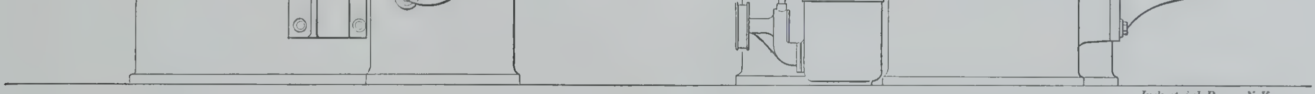
Industrial Press, N.Y.

Fig. 2. Side and Front Elevation of Milling Machine.

The feed is obtained by means of five-step pulleys and a double set of change gears so that there are ten feed speeds. By means of a clutch the feed motion can be thrown out either by hand or automatically at any point. The dividing head is driven from the feed gears by means of a worm and set of change gears. These change gears must be so proportioned as to give a complete turn to the dividing head while the cutter head is traveling the length of the lead of the worm being cut. The depth of the cut is adjusted by an index plate on the screw which controls the cross motion of the dividing head slide, while a stop prevents too deep cutting. By means of a templet or gage that can be attached to the center of the swivel plate the cutter can be brought exactly to position. The machine has a capacity for cutting worms up to 13.8 inches in diameter with a threaded length of 17.7 inches. The builder is Reinecker, Coblenz, Germany.

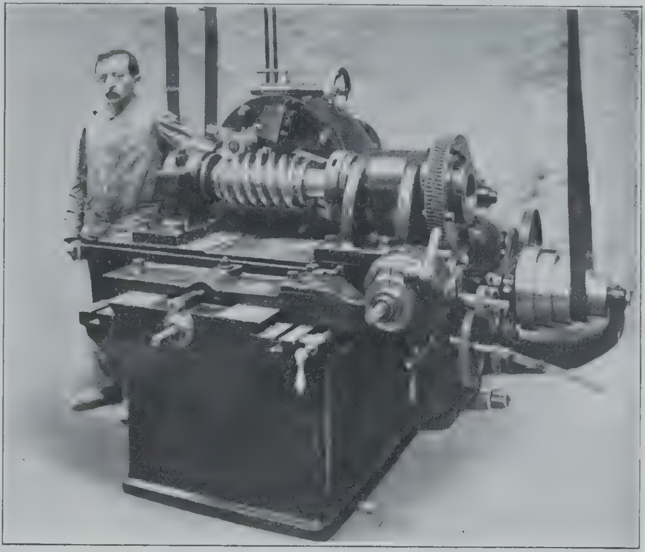

Fig. 1. German Worm Milling Machine.

* * *

The expense of sending out a competent mechanic to set up and explain the working of certain classes of machinery, is in many cases, a heavy item to the manufacturer who is, of course, obliged to count it in the selling price of his product. With some kinds of apparatus it is impossible to do otherwise than send a man along, but the camera is now being used to quite an extent as a setting-up instructor, and there is undoubtedly a much wider field for its use than is now cultivated. An instance of the liberal use of the camera to explain the set-up and use of a machine recently came to our notice. A certain firm make a machine for bending rails for railway frogs and switches. There are a large number of combinations that can be effected for different classes of work, angles, etc., and to explain them so as to render needless the sending out of an instructor, a number of views, thirty-seven in all, were taken showing each and every operation. Half-tone cuts made from the photographs were printed in a pamphlet with simple instructions for each operation. While the initial cost of such a pamphlet is comparatively heavy it requires the traveling expenses of but few trips to balance it. Besides, there is the great advantage to the purchaser of having plainly illustrated instructions always at hand where they can be referred to when occasion demands.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

AUGUST, 1903.

NET CIRCULATION FOR JULY, 1903,—25,247 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

SAFE CRACKING AS A FINE ART.

It is a strange but undeniable fact that some of the best machinists and toolsmiths have been notorious safe crackers. That lawbreakers of this class are wideawake and quick to avail themselves of the advantages of new discoveries which may be perverted to unlawful ends, is well known. The battle between the safe makers and the safe breakers has been waged with a persistence almost equal to that between armor and ordnance. When the safe maker finally succeeded in making safes of chrome steel plates that could not be drilled, the safe breaker simply blew the doors off with nitro-glycerine. Then the safe doors were made to fit so tightly that the nitroglycerine could not penetrate into the crack around a door under ordinary conditions. But even with the most perfect construction a crack exists around every safe door and a film of powerful explosive, be it ever so thin, will do the business if it can be gotten in place. To overcome the difficulty the safe breaker simply knocked the handle off the door, applied the nozzle of an air-pump to the opening and pumped the air from the interior. The atmospheric pressure forces the nitroglycerine into the crack—a small quantity, it is true, but sufficient for the purpose.

At last when the safe maker had succeeded in making a safe upon which the last described nefarious practice could not be practiced, thermit made its advent. The criminal class recognized the value of this strange compound long before the average honest man even knew of its existence. One of the amusing experiences of the American representative of this German product, was the receipt of a $1 bill from a convict in a State prison, with the request for a sample of what he had recognized to be an ideal means for overcoming the resistance of hardened steel. Needless to state his money was returned and the order unfilled. The safe makers are greatly concerned regarding the possibilities of thermit as affecting their industry, and not without good reason. The article upon thermit which appeared in MACHINERY several months ago attracted widespread attention and brought many inquiries to this office, among them being two from prominent safe builders who wished to investigate the subject.

In a lecture on radium and similar substances, selenium, etc., delivered by William J. Hammer before the American Institute of Electrical Engineers, April 17, he referred to thermit and said: "I have seen steel safes in which enormous holes had been burned by employing thermit, and it would be possible for a burglar to carry some thermit in his pocket and burn a hole in a safe large enough to insert his arm and extract the valuables. I saw in Germany last summer a substance called 'anti-thermit' which it is intended to place in the lining of safes to prevent the reaction taking place, thus protecting the safe." Mr. Hammer then suggested that a selenium cell could be used for the purpose of sounding a burglar alarm the moment light was admitted to the interior of the safe, etc.

* * *

COMBINING PRACTICE WITH EDUCATION.

Union College, situated at Schenectady, N. Y., in the city where the main works of the General Electric Company are located, is one of the venerable institutions of learning. It not only was one of the first to be founded as a classical college, but was one of the first to take up scientific and technical education, being superseded in the latter respect only by Rensselaer Polytechnic Institute at Troy, N. Y., and possibly one or two others. An engineering course was established in 1843, and in 1895 was added a department of electrical engineering.

It is now reported that an arrangement has been made with the General Electric Company whereby a school for engineering has been organized in connection with the college that will be unlike any other that we know of. Mr. Steinmetz, the famous mathematician and electrical engineer of the General Electric Company, will be the director of the school, with R. Neil Williams, a young Californian who has just returned from a course of scientific work and study abroad, as his principal assistant. The first class is now at work and seventy applications have already been received for the freshman class of next term. Lectures will be given by employees of the General Electric Company and the practical application of principles will be demonstrated, not only in the class rooms but in the General Electric Company's shops. In the summer those of the students who wish to pursue their inquiries further will put on overalls and go to work in the shops of the company.

This is the first instance in this country of a technical school which gives degrees, becoming associated with a large manufacturing establishment, and is undoubtedly a step in the right direction. It is substantially the plan advocated by Prof. Sweet many years ago in a discussion on technical education and will be of particular interest to members of the American Society of Mechanical Engineers who had the pleasure of visiting Union College and its grounds during the recent meeting at Saratoga.

To the outsider, Union College does not appear to be on the top wave of prosperity. Its buildings are mostly very old, and as an institution it does not have the up-to-date look of many other colleges. But if the plan now projected can be carried out, it will nevertheless have taken a very progressive step and its course in electrical engineering ought to become one of the most popular in the country. Students of electrical engineering will here have relatively the same advantages that will doubtless be enjoyed by students in metallurgical subjects at the great Carnegie Institution to be established at Pittsburg. Why should not the idea be carried still further? Why should not students in mining be educated under the auspices of one of our great mining companies? Hospitals are founded, ostensibly for charitable purposes, but frequently with the principal object of affording practical training for medical students. Law schools are established in cities where court practice can be studied. Boys in agricultural schools have to farm it. It is also in accord with modern ideas that a school of engineering should be intimately associated with workshops where students may have free access and not only gain practical experience through observation, but through practical work as well. Only a manufacturing company of large size could well carry out such a scheme and the objection might be raised that they would try to use the students in a way to make the most money possible from their services. Probably they would do this, but the student would be acquiring experience all the time and that is the thing most needed by him.

NOTES AND COMMENT.

A striking example of delicacy in weighing has been referred to by J. A. Brashear, the widely-known instrument maker. At the International Bureau of Standards near Paris is a balance mounted in a vacuum in a heavy glass case, and provided with mechanism for handling the weights from a distance great enough to give security against influence of the heat of the body. So perfectly made are instrument and accessories that when two kilogramme weights are placed side by side on each pan the indicator finally comes to rest at zero. But when one of the weights in one pan is placed upon the other the indicator shows the opposite pan to be slightly the heavier, the almost incredible explanation being that one weight is made lighter by its slight increase of distance from the earth's center. This is delicacy indeed—if true.

In the April, 1901, issue an immense stone turning lathe was described which was built in Philadelphia for turning and polishing very large granite columns at Vinalhaven, Me. As subsequently recorded the attempt to turn and polish these columns, which were about 54 feet long and 6 feet diameter, terminated in failure, two or three of the columns having broken in two during the polishing process. Strange to say no attempt seems to have been made to steady-rest the columns, the immense weight (about 140 tons) having been supported entirely from the ends. So the original plan of the architect to make the columns monoliths was abandoned, and instead they are made in two parts, 36 feet and 18 feet long, respectively. Two of the columns, *i.e.*, two 36-foot and two 18-foot pieces, with their pedestals, have arrived at New York and are now in process of transportation to the site of the cathedral St. John the Divine on Morningside Heights. The larger pieces weigh over 90 tons and the smaller ones about 40 tons each. The value of each column with its pedestal is placed at $25,000.

HOW IS THIS FOR A HOWL?

We have just learned a thing that some have often feared would come to pass—that the British Isles no longer have existence. The news is American in origin, so that there can be no doubt as to its truth. Furthermore, the British colonies are very much in evidence, but they are bereft of the motherland, and are led to seek shelter under the wings of the U. S., for all the world like an old clucking hen calling another's chickens together. We do not read this statement in so many words, but the Pennsylvania Steel Co. has had the audacity to send us a copy of its map of the world with the British Isles deleted—lost in the recent rains perhaps? A couple of years ago it supplied the Gokteik Viaduct in Mandalay, and lets the world know all about it in an illustrated *brochure*, "From Steelton to Mandalay," a sort of characteristically Yankee "lick-creation" story. The map shows the route followed in the conveyance of the construction from Steelton Works to its destination, and while it shows such places as Iceland, Tasmania, Madagascar, and many even less important places, it wipes out these poor little islands as with a sneer of contempt. It is the kind of insult that some indiscreet U. S. traders are committing every day in their excessive pushfulness. We should like to think that the omission was only an error, but it is too strange and remarkable for that. The incident may afford our manufacturers some little amusement, though it is an exceedingly poor joke if such it is intended to be.—(London) *Electrical Review.*

JERUSALEM THE GOLDEN.

An engineer who has been traveling in the Holy Land contributes a paper upon his trip to the Engineering Association of the South in which he rather shatters the golden features that we are accustomed to associate with the city of Jerusalem. He says:

> The most remarkable feature of the city, from the engineer's point of view, is the total absence of all the blessings associated with good engineering. Pure, clean water, the one good thing above all others to be prayed for in the Orient, is more scarce now than in the time of the Jewish kings. Now, as then, water is carried in goatskins, on the backs of men, women, and donkeys, from Siloam's pools up a steep, dusty road, one-half mile, to the streets of the city, and there retailed by the gallon; but the aqueducts that, in ancient days, carried water from Solomon's pools and springs, about fifteen miles south of the city, are in ruins. The dull, heavy hand of the Turk rests, as a curse, over the country. There are no sewers, no street lights or fire department, and the refuse from the streets and back yards is, not very efficiently, carried off in baskets on the backs on donkeys. The patient, gentle, frugal little donkey is in evidence everywhere. Women, children, and big, heavy men straddle his back; he carries up steep, rocky hills burdens much heavier and bigger than himself, and you see children pet him and play with him in the back yards as our children do with their dogs, and he is invariably treated gently and kindly by his owner.

HIGH-SPEED PLANER WORK.

The reference to high-speed planer work done in the Juniata Shops of the Pennsylvania R. R. at Altoona, Pa., was in error in stating that Bement, Miles & Co. were the builders of the frame planer which is being successfully operated at a cutting speed of 40 feet per minute. The Pond Machine Tool Co. are the makers of this machine. Further particulars recently received regarding the work done are interesting. A pair of locomotive frames for the class of P. R. R. freight locomotive known as H6, are planed and finished in 16 hours. These frames are of the four-pedestal type, 27 feet long, 30 inches wide and 4 inches thick. It is thought that this beats the record for frame planing in any locomotive building shop.

A test was recently made to determine the power required by a 72-in x 72-inch Pond cylinder planer running at a cutting speed of 35 feet per minute and working on four cylinders of the E3a type weighing 3,700 pounds each. The machine is driven by a 30 H. P. General Electric motor of the CL type. Two tools were cutting, one tool taking a chip ½ inch deep, feed 3-16 inch and the other 3-16 inch deep and ⅛ inch feed. The power required when cutting was 18.3 horse power; to reverse the platen at the end of the cut 70.7 horse power; to return, 7.3 horse power; and to reverse for the cut, 47.1 horse power. It is expected that 35 feet cutting speed will be adopted in these shops as the standard for planer work.

* * *

DEATH OF I. MC KIM CHASE.

Isaac McKim Chase, M.E., of Washington, D. C., whose name and writings have frequently appeared in this journal, died of tuberculosis at Atlantic City, N. J., on June 7. He died as he wished to do, with armor on, still fighting. His latest contribution to MACHINERY appeared in the June issue. Mr. Chase was born in Baltimore, Md., May 27, 1837—an American of Americans, being a descendant, through his father, of William Chase, who came to America with Gov. Winthrop in 1630; and, through his mother, of the Silver and Crusee families of Revolutionary prestige in New Jersey. Mr. Chase's entire career was consistent in developing his natural mathematical and mechanical genius. He received a thorough training in drawing and marine engineering, and always proved competent to cope with important and difficult problems. His chief life work was in the Washington Navy Yard as foreman of Pattern Department, to which he was first appointed in 1861. His recognized ability caused his selection from time to time for work requiring special qualifications. He was sent to Europe in 1878—the time of the Paris Exposition—with a device for signaling, which has since been adopted by the French and Russian governments. He gave up his position in the Navy Yard for several years to design the Lanston typesetting machine, for which he predicted a great future. This work brought him a diploma from the Columbian Exposition in 1893. Mr. Chase returned to his post in the Pattern Department and remained there until his death, developing and enlarging the scope of the Washington yard, and making work possible there that had previously been of necessity done elsewhere.

Mr. Chase patented many devices, his latest in 1902 being a screw-propeller, from which much is expected. His contributions to the literature of mechanical engineering and pattern-making have been numerous and valuable. His book on "Screw Propellers and Marine Propulsion" (published by John Wiley & Sons) has had a large circulation, and has recently gone into another edition. His latest work, "The Art of Patternmaking," by the same publisher, is now in press, and its publication is anticipated by those interested in this subject as almost the final word along this line in which his experience was practically unlimited.

POWER PLANT WITH NOVEL FEATURES.

UTILIZING THE WATER OF CONDENSATION AND THE CONDENSING WATER.

GEO. L. FOWLER.

In the remodeling and enlargement of the repair shops of the Chicago, Milwaukee & St. Paul Railway, now in course of execution, some novel and interesting features are to be introduced, based upon the past experience with the power plant heretofore used for driving the car shops. As in all of the large railroad shops that have grown from comparatively small beginnings, there were necessarily a number of small and independent power plants for the service of the several departments. Of these that of the car shops was the largest, then came the machine shop, followed by smaller installations in the foundry, small planing mill, roundhouse and the like. With the new power house all of these separated plants, with the exception of that of the car shops, which will be retained, will be concentrated in one, and in this a valuable principle of operation will be borrowed from the older one.

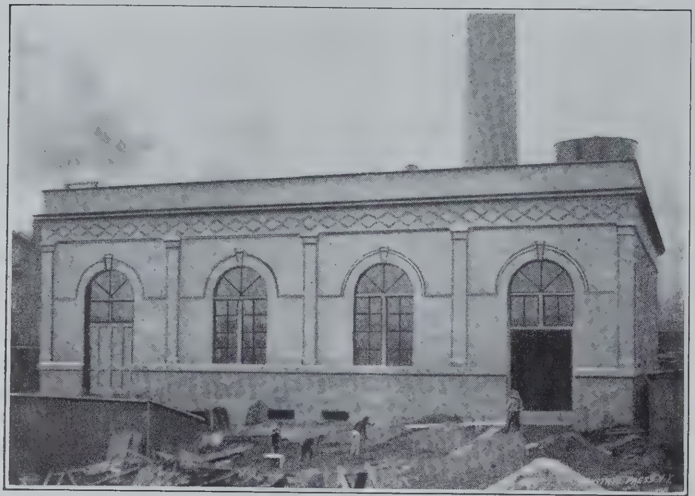
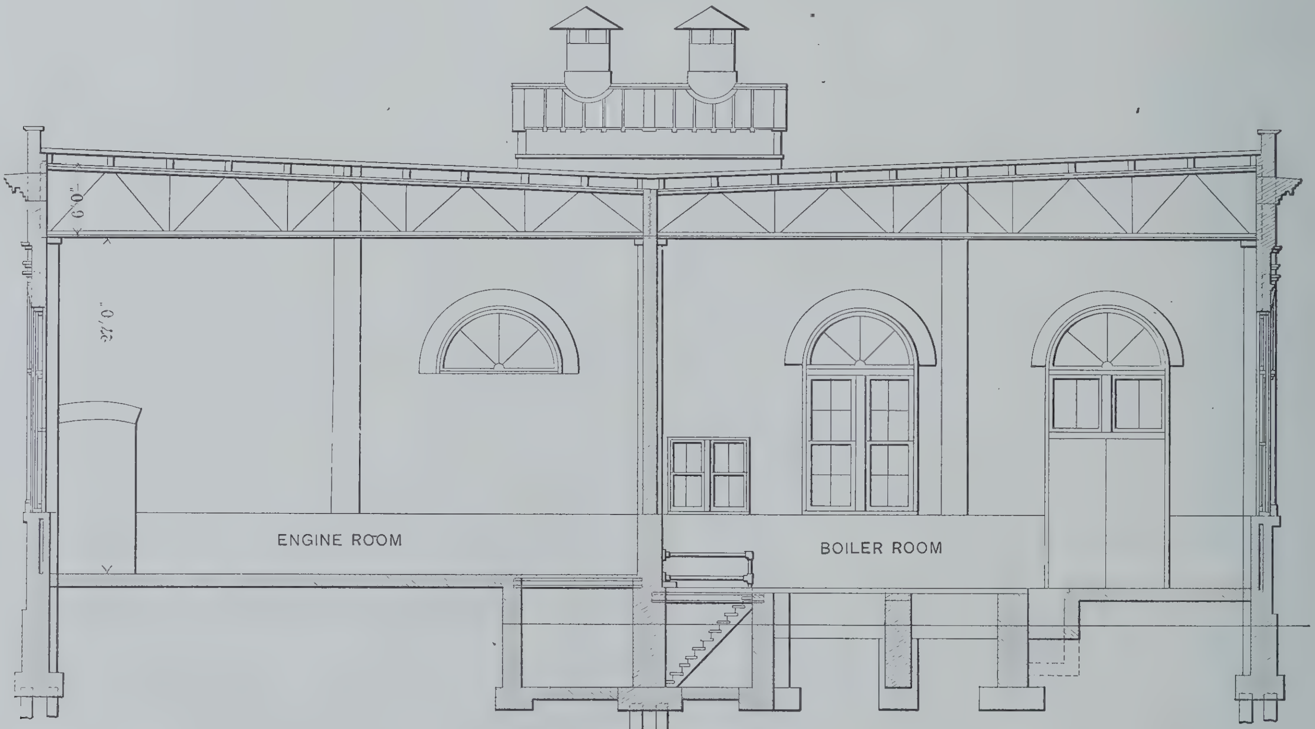


Fig. 1. Exterior of Model Power House at the Milwaukee Shops of the St. Paul Railway.



Industrial Press, N.Y.

Fig. 2. Cross-section of Power House showing Roof Construction.

The car shop engine is a cross-compound Corliss engine of about 275 horse power that is ordinarily worked condensing. The water of condensation is obtained from an artesian well, which is forced to give a sufficient flow for the purpose by means of an air jet carried down to the bottom of the pipe. Ordinarily this water of condensation is turned into the sewer as soon as it has done its work with the engine. Here, however, it is saved and stored in a large cistern located next the machine shop and from it is drawn the supply of water used for washing out the boilers in the roundhouse.

The water itself is not altogether suitable for boiler purposes, but answers admirably for the work done with it. In this way the economical advantages of working the large engine with a condenser are obtained, coupled with that of the use of hot water, which it has cost nothing to heat, for washing out the locomotive boilers in the roundhouse.

The water used at West Milwaukee for filling the locomotive tanks is from Lake Michigan, and is obtained from the city on meter measurements, about 600,000 gallons being used every twenty-four hours. In designing the new plant advantage was taken of the fact that this large quantity of water would be required for the locomotives, and arrangements have been made for first utilizing it as a condensing water for the engines in the new plant. Accordingly a large standpipe capable of holding about 300,000 gallons is located near the power house. It can be seen projecting above the roof of the same in the half-tone reproduction of the photograph. The water is taken from the city mains, used for condensing purposes and then pumped into the water tower, whence it is drawn off to fill the tanks of the engines.

The temperature of the lake water runs from 50 to 60 degrees and with it a vacuum of from 27 to 28 inches can be maintained at the engine. If at any time it should be found that the condensing water reaches the tank of the locomotive at so high a temperature that the injectors will not work, the vacuum will be lowered and water of a lower temperature be sent to the locomotives. Here, too, there is a twofold saving, in the possibility of working the engines condensing and the use of hot water on the locomotives.

Turning now to the details of the power house, it is of the yellow Milwaukee brick and of a pleasing architectural design, as indicated by the photograph. In plan it is nearly square, measuring 97 feet by 100 feet, with a clear height of 27 feet above the floor of the engine room to the bottom of the roof girders. It is divided into two nearly equal parts by a brick wall which thus separates the engine from the boiler room.

At one end of the engine room there is an extension of 16 feet in which are located the pump and condenser rooms.

The boiler equipment, as at present laid out, consists of two batteries of Babcock & Wilcox water-tube boilers, with a total rated capacity of 1,200 horse power. Space is also provided for the installation of a third battery, so that the ultimate capacity will be 1,800.

In the engine room there are two Nordberg cross-compound engines with 15-inch and 26-inch cylinders and a piston stroke of 36 inches. Here, too, space is left for a third engine of the same size. Each of these engines drives a 200 kilowatt generator built by the Milwaukee Electric Co. In addition to the two large ones there is a 160 horse power Westinghouse engine driving a 100 kilowatt generator.

As in all modern railroad shops compressed air is extensively used for a great variety of purposes about the premises, a compound Allis compressor with air cylinders 13 inches and 22 inches in diameter, and steam cylinders of 14 inches and 26 inches, with a common piston stroke of 36 inches has been installed.

In the pump room there is a wash-out pump with a capacity of 600 gallons, and a fire pump of 4,000 gallons per minute. The condenser room contains a Cochrane feed-water heater, a Wheeler surface condenser and the boiler feed pump.

The stack stands clear of the building and is 9 feet inside diameter.

The illustrations that are given of the building show its appearance and the arrangement of the machinery very clearly, the characteristic feature of which has already been elaborated. In regard to the distribution of the power in the shops, that will be taken up in a future article.

* * *

FRICTION TEST OF OILS.

ARTHUR W. COLE.

In the operation of shafting and machinery, there is always a great loss of power on account of the unavoidable friction in the numerous bearings. The manufacturer is therefore constantly striving to lessen this loss by reducing to a minimum the friction between all the moving surfaces. The most common means of doing this is to introduce oil or grease into the bearings in order that the rubbing surfaces may not come together, but will be separated by a very thin film of the lubricant. At the present time the use of oil is being replaced, in a measure, by boxes lined with graphite and also roller bearings. The use of oil, however, will never be wholly superseded by these more modern methods. The great difficulty in using oil is to determine exactly the proper one to be used in the bearing in question. Until within a very short time, there has been no means of accurately determining the value of an oil for reducing friction. The only methods of determining this property have been the comparatively crude ones of the viscosity pipette which is used by the Pennsylvania Railroad, also by the feeling of an oil when rubbed between the fingers and by actual test in the bearing of which it is to be used.

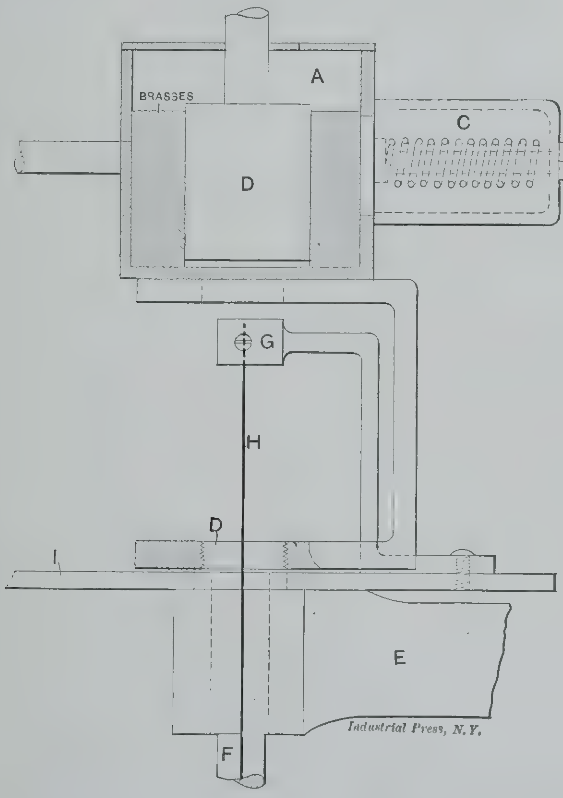


Fig. 1. Section through Oil Testing Machine.

Without doubt the long-felt want of a better and more accurate method of the determination of the value of an oil will soon be filled by the very simple but ingenious machine which has recently been completed by one of the Professors of Mechanics in an eastern Institute of Technology, by the aid of which the writer obtained the results contained in this article. In this machine an ordinary 14-inch sensitive drill is used for the frame and driving part. The test journal within the cup shown at *A*, Fig. 1, has its axis vertical, and is suspended from the drill spindle by means of a Hooks universal coupling, and runs between two opposing bearings in the cylindrical cup, which may be filled with the oil to be tested. The load is placed upon the bearing by means of a helical spring, contained in the sleeve *C*. This spring has a capacity of about 900 pounds. The tension may be adjusted by means of a screw and is also provided with a device for quickly applying or removing the load without changing the adjustment. The cup *A* has a cover in which is a hole for inserting a thermometer.

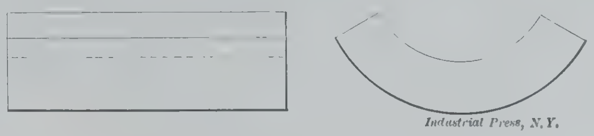


Fig. 2. Brasses used in Oil Testing Machine.

The cup and the parts attached to it are carried on a spindle *D*, which is 1⅜ inch in diameter and turns freely in the sleeve supported by the arm *E*, which is attached to the drill frame. The spindle *F* extends nearly two feet below the sleeve, and is suspended from a fixed bracket *G* by a tempered steel wire *H*, passing through the spindle and fastened to its lower end. When the machine is in operation the suspended parts swing freely to such a position that the torsion of the suspension wire balances the friction at the test journal, and the angle of torsion may be read from a graduated disk at *I* by means of a pointer. The suspended parts are counterbalanced by weights, so that there is no pressure of the revolving spindle against the sleeve when the oil in the bearing becomes evenly distributed. The advantage of suspending the apparatus on this steel wire is that, in this way, large indications are obtained for a very small amount of friction at the surface of the journal. In cases where great friction is encountered, a helical spring is placed on the spindle *F*. The cup and the test journal are arranged so that they may be readily heated by a Bunsen burner.

The test journal which is contained in the cup *A* is 1⅜ inch in diameter, of tool steel hardened, ground and polished, The brasses which form the bearing are sectors cut from a brass ring which has been carefully finished, and each has an arc of about 120 degrees, and are about two inches long. The brasses are fitted with great care so that they will cling to the journal when perfectly clean, after the manner of surface plates. Fig. 3, on the next page, is a detail of one of the brasses of the bearing.

It is well to calibrate the machine each time before running a series of tests. By this it is meant that it is necessary to test the torsion of the wire to find its constant or the moment in inch pounds required to twist the pointer through one degree as indicated on the graduated table. The moment is then reduced to pounds acting tangentially to the surface of the journal. This is accomplished by winding cords about the drum, and carrying them over pulleys and placing known weights upon the scale pan attached to the cord. If the diameter of the drum is then measured to the middle of the cord, that is the actual diameter of the drum plus the diameter of the cord, and the diameter of the journal, the length (L) and width (B) of the brass bearings are also measured; the intensity of the pressure is then equal to the total load divided by the projected area, the projected area being equal to BL for each brass. The friction per square inch may then be stated as the total friction divided by the total surface, the surface being equal to S, the length of the arc times L, the length of the bearing for each brass.

Before starting the test, the oil cup, the journal and the brasses must be thoroughly cleaned. The most effective method of doing this is to wash the parts carefully with kerosene and wipe with a piece of clean waste. The bearing surfaces should be cleaned with special care and should not be touched thereafter with the fingers. Great care should also be used not to scratch or bruise any of the parts. The load should not be applied to the journal until after the machine is started and should be removed before stopping, otherwise the brasses will seize the journal so that it will be very difficult to release them.

When all is in readiness the test machine is started, the oil poured in, and cover containing the thermometer fastened in place. The load is then applied by means of the spring. The revolutions of the journal are noted at the beginning and the end of each run. A small Bunsen flame is then placed under the oil cup so that the cup and its contents may be slowly heated. The reading of the friction is taken by means of the pointer every five degrees F. or two degrees C. rise in temperature of the oil. This process may be carried on until the oil reaches a temperature from 150 to 300 degrees F. according to the kind of oil tested. If the revolutions per minute and also the total load on the journal are known, which may be read in pounds from the pointer on the spring after the manner of an ordinary spring balance, also the temperature of the oil, and the number of degrees twist in the wire, we may readily determine the coefficient of friction of the oil.

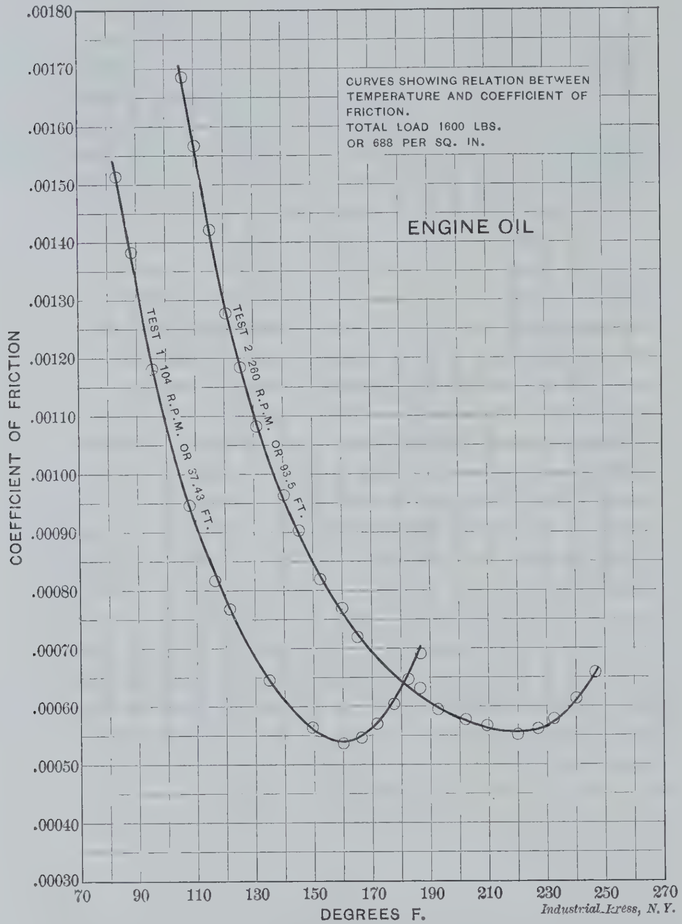


Fig. 3. Relation between Temperature and Coefficient of Friction.

It is first necessary to calibrate the wire, and this is done by placing one-pound weights in a scale pan attached to a string wound around the drum as previously explained.

From measurements taken we have:

Diameter of drum	4.138	inches
Diam. of string wrapped around drum	.0245	"
Effective diameter of drum	4.163	"
Diameter of journal	1.3745	"

To calculate the equivalent force, which, when applied tangentially at the surface of the journal, will turn the pointer the same distance that it was moved by the weight in the scale pan, we have the proportion: Force at surface of journal is to the weight in the pan as the diameter of the drum is to the diameter of the journal, or,

$$\frac{X}{2} = \frac{4.163}{1.3745}$$

where X is the desired force at the surface of the journal. From this we find that X or the desired force tangential to the journal's surface is equal to 6.07 pounds, the wire being twisted 155 degrees as indicated by the pointer on the graduated table; therefore the force required to twist the wire one degree is equal to $\frac{155}{6.07}$ or .0391 pounds.

In Test 1, which was run on engine oil, the speed was 104 revolutions or 37.43 feet per minute; total load was 1,600 pounds or 688 pounds per square inch. At 75 degrees F., the spring was twisted through 81 degrees. From calibrating the wire it was found that one degree equaled .0391 pounds, therefore the total friction at the surface of the journal is .0391 times 81 or 3.1671 pounds. From measurements of the journal bearing we find that there are 5.771 square inches of bearing surface, therefore the friction per square inch of bearing surface is equal to 3.1671 divided by 5.771, which equals .548 pound per square inch. The coefficient of friction of the oil is then found by dividing the total friction by the total load on the journal, or 3.1671 pounds divided by 1,600 which is equal to .00198.

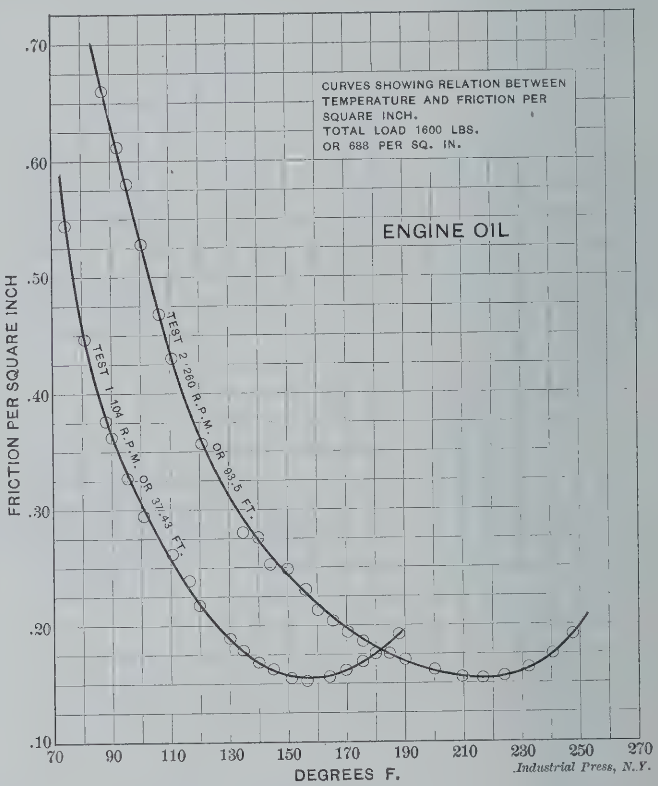


Fig. 4. Relation between Temperature and Friction per square inch.

By a series of such calculations the curves in Figs. 3 and 4 were drawn showing the relation between the temperature and coefficient of friction, and temperature and friction per square inch. From these curves we note that the pressure per square inch and the coefficient of friction vary in a similar manner as the temperature rises. We also notice that the friction steadily decreases for a time as the temperature rises until at last a point is reached where the coefficient of friction increases as the temperature is still further raised. This shows that there is a certain temperature for every oil, which temperature will vary according to the load applied, at which the oil becomes so thin that it can no longer support the load and breaks down, causing the friction to increase rapidly. It is also evident that the nearer the oil can be worked to the temperature at which the breaking-down occurs, the better results will be obtained, in so far as a low coefficient of friction is concerned.

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A French inventor has a method for typesetting by telegraph, thus doing away with the transcription of press dispatches.

PISTONS AND PACKING RINGS.—7.

J. H. DUNBAR.

In response to a request to engine builders for blue-prints, etc., of their pistons and packing, I am able to show a number of pistons as they are made to-day. They are given in the order in which they were received.

Fig. 1 shows the Buckeye Engine Company's (Salem, O.) piston for their 18x30-inch Tangye engines. The spider is evidently cast iron, with flange and follower turned an inch smaller in diameter than the cylinder. The piston is packed with two eccentric rings slightly L-shaped in cross-section, so as to make them flush with the ends of the piston. The rings are comparatively heavy, and not liable to break except in a general smash-up. I don't know what excuse lighter rings have for breaking, but they do break just the same. I suppose the packing rings are turned to the diameter of the cylinder, and then set out as occasion requires, with the six ⅞-inch setscrews, five with flat springs on their outer ends, and the bottom one resting in a counterbore in a plate fitting the inside of the rings. This plate not only makes an excellent joint-cover, but also, by being bolted to a ring at each end, leaving one end of each ring free, makes a good doweling arrangement. Right here it will be seen that if the rings are put in the cylinder as shown in the blue print, there is nothing to stop a leak at the joint. This is no doubt an error in the print, for the Buckeye people believe in keeping all the live steam in one end of the cylinder. In their circular they speak of this as a balanced piston, which I take it means that no steam pressure gets inside of the rings, or if it does it cannot force the rings out, owing to their being clamped in their groove. If the latter, it is practically an adjustable solid head, so to speak. The reader will note that the rings have six inches face, and with this breadth they may be perfectly free in the cylinder, and still not leak appreciably. They will never leak at the bottom, as the weight of the piston will hold them to the cylinder, but I am of the opinion that steam will get between the cylinder and rings part way across their face at the top, and give them a steam load to carry on the bottom. As a whole, the design is a fine one, and will compare favorably with any piston that we shall find. There is nothing to wear out about this piston but the rings, and they are made with a generous amount of stock for that purpose.

The Fishkill Landing Machine Co., Fishkill-on-the-Hudson, N. Y., make their pistons as shown in Fig. 2, having one eccentric snap ring with joint cover riveted to one end of the ring. The ring is not shown to be doweled. The company says of this piston: "The piston is made very strong, and securely fastened to end of steel piston rod. The weight of the piston is carried on a center or junk ring, adjusted by screws in the spider so that it will sustain all the wear; while the spider, follower and packing ring are kept central in the bore of the cylinder. The packing ring is elastic and self-adjusting, forming an effective steam joint with a very small amount of friction, and consequently the wear on it is trifling." Probably a very slight improvement would be made in this piston if the edges of the ring were undercut to give concentric groove wear. This seems to be all that can be said of this piston, except that which applies to it as a type, which will be noted later.

Fig. 3 shows an 18-inch piston for a Williams vertical engine, made by the Quincy Engine Works, Quincy, Ill. This sketch shows their piston to have several features not usually seen—for example, there is no bottoming clearance between the packing ring and the piston body, according to the dimensions given. In my opinion there should be some clearance to compensate for unequal temperatures of packing ring, bull ring and cylinder, which may be considerable, at times, depending upon the carelessness of the engineer. Then, too, with the packing rings solid against the body of the piston they have to guide the piston in the cylinder, while properly the bull ring should do that. A material list furnished with the blue print shows that nine springs are required for each engine. Now it is somewhat difficult to divide nine springs into two equal lots, one lot for each packing ring, and have nothing but whole springs. It takes a resourceful fellow and a blacksmith shop in his vicinity, to make luck out of odd numbers, in cases of this kind. It seems plain that nine springs are needed to each packing ring. These springs which are slightly elliptical, tend to force the rings out to the cylinder, but gibs hooking over lugs on the inside of the rings at their joints, prevent the springs from doing so, very much in the same manner as Prof. Sweet holds his packing rings, which was shown in the sixth installment of this series.

It seems to me that if the radial-acting packing ring springs in Fig. 3 were left out, and a tangent-acting spring put in at the joint, to spread the ends apart, leaving the ring free to vibrate slightly crosswise of the cylinder in its groove, to compensate for any imperfection of alignment due to cross-head or guide wear, the piston would be an excellent one. It is not the intention to imply that the Williams piston is not a very perfect one. The writer has been guided only by a study of the blueprint, in what he has said.

The Fitchburg Steam Engine Co., Fitchburg, Mass., make pistons for cylinders 44 inches in diameter, with bull ring and two snap packing rings, the latter being only ¾ inch wide. While it is unusual to make packing rings of that diameter so narrow, there does not seem to be any good reason for making them wider unless "because the other fellows do" is considered to be sufficient grounds for making the change. Another feature of this design is its simplicity. There is not a piece that can be dispensed with, unless it is a packing ring. The two-ring piston is largely in the majority at present, especially for smaller cylinders, say 20 inches and under, but the single-ring piston is undoubtedly growing in popularity. The Fitchburg piston, shown in Fig. 4, has the lower half of the bull ring babbitted to insure the least wear possible on the bottom of the cylinder. Its large wearing surface will also be noted.

The William A. Harris Steam Engine Co., Providence, R. I., use the Corliss piston, and, I believe, are the originators of the type. They say of their piston: "The packing ring is first made in one piece, and is turned to the exact diameter of the cylinder; it is then divided into sections, and the joints made tight by inserting bronze plates. The ring is pressed outward with German silver spiral springs, one spring being placed under each plate. The groove in the junk ring is turned just deep enough to permit the packing ring to go below the surface. Whenever it is necessary to remove the junk ring the packing ring is held in place with wire pins, pressed through holes for that purpose. The piston head is provided with bronze adjusting bolts, so that the piston rod can be set and kept in the center of the cylinder." The blueprint, Fig. 5, shows their 24-inch piston so clearly and completely, that there need be no further description. We may note, however, that the bottom clearance under the packing ring is only 1-32 inch, an ample amount, showing that details of the least significance are made with reference to requirement rather than precedent.

There are two very distinct types of bull ring pistons. One is the Corliss, where it forms the entire outer part, or shell of the piston, and has grooves for the packing rings, all as shown in Fig. 5. The other is the original Dunbar, invented by Mr. Henry D. Dunbar in 1861, in which the bull ring forms that part of the piston between the packing rings and bottom for grooves. The Dunbar is strictly a two-ring piston, but I have been very successful in making them last twice as long by using one at a time, on the principle that if one ring lasts one year two rings will last two years. The only difference that I can see in the operation, with one ring removed, is that the cylinder clearance becomes very slightly greater at one end than at the other, and a shoulder is worn in the cylinder, marking the end of the ring's travel. The Corliss piston is admirably adapted to a single packing ring, or a "lot of 'em." With a three-ring piston it is dangerous to try to get the middle packing ring to run over the counterbore, even at one end of the cylinder.

It seems to me that a single-ring piston for horizontal engines of the Corliss type, has in addition to its weight, a very considerable steam load to carry. It is expected that the bottom of the bull ring will make a steam-tight joint with the bottom of the cylinder, and that the steam will hold it down as an unbalanced slide valve is held to its seat. With a view to relieve the piston of this steam load, I suggest that the

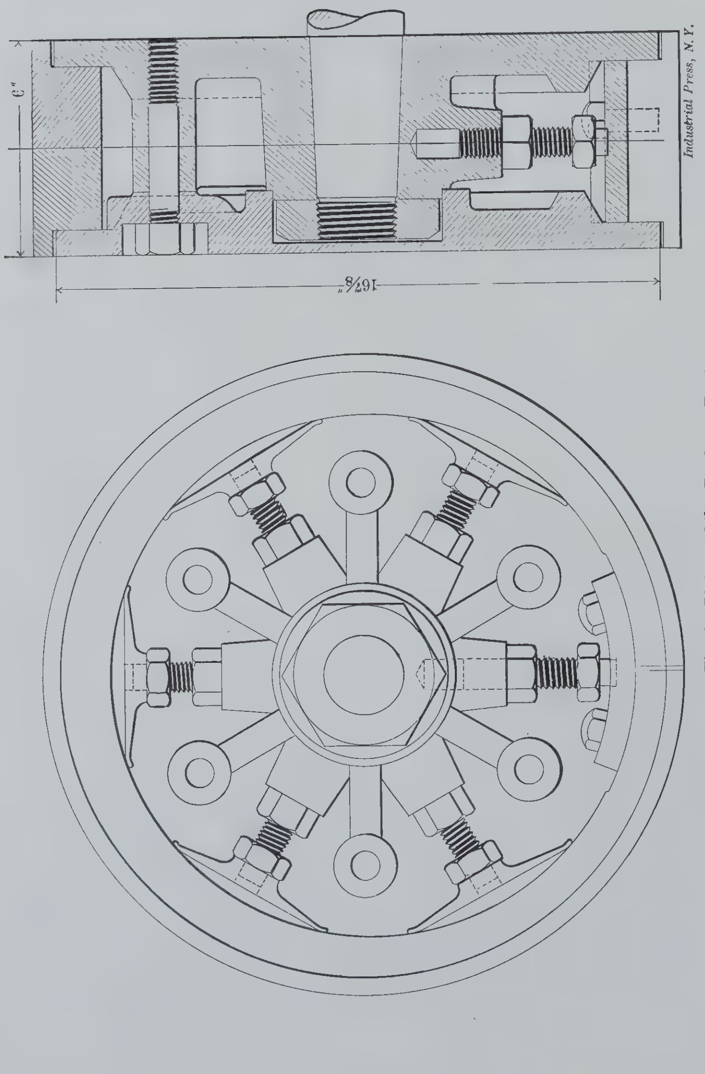


Fig. 1. Piston of the Buckeye Engine.

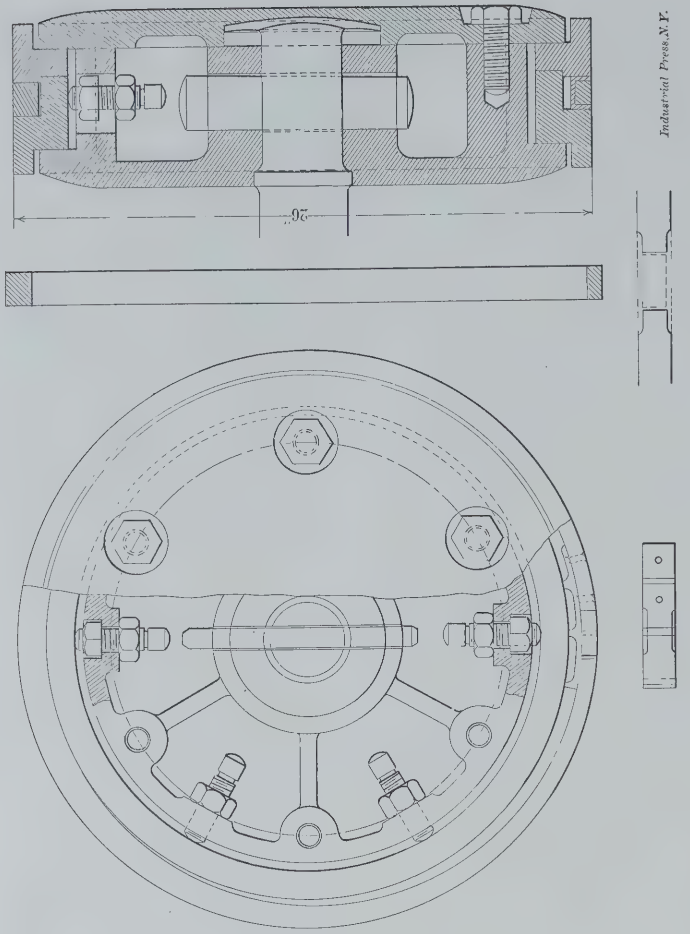


Fig. 2. Piston of the Fishkill Landing Machine Co.

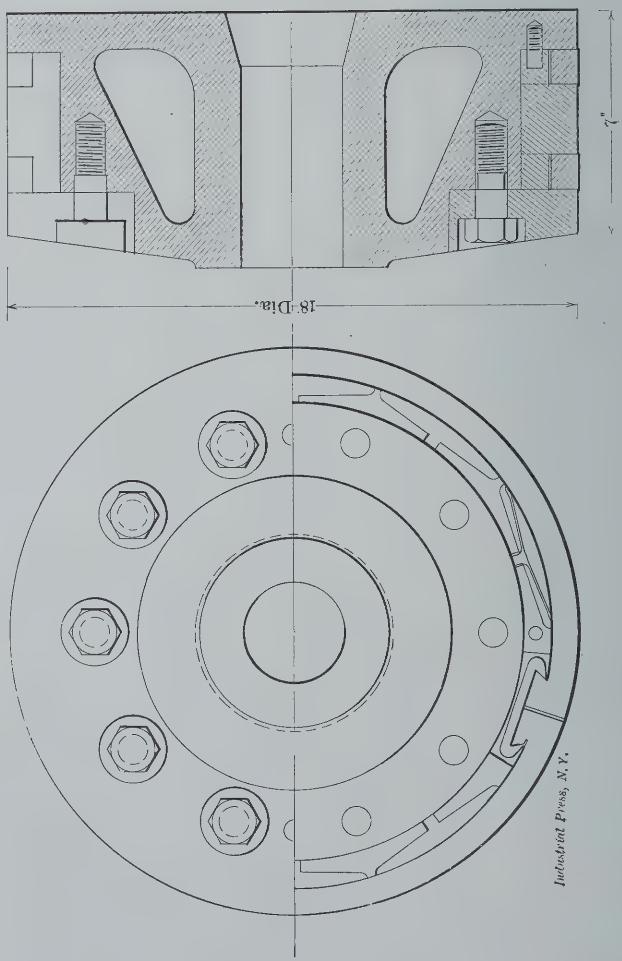


Fig. 3. Piston of the Quincy Engine Works.

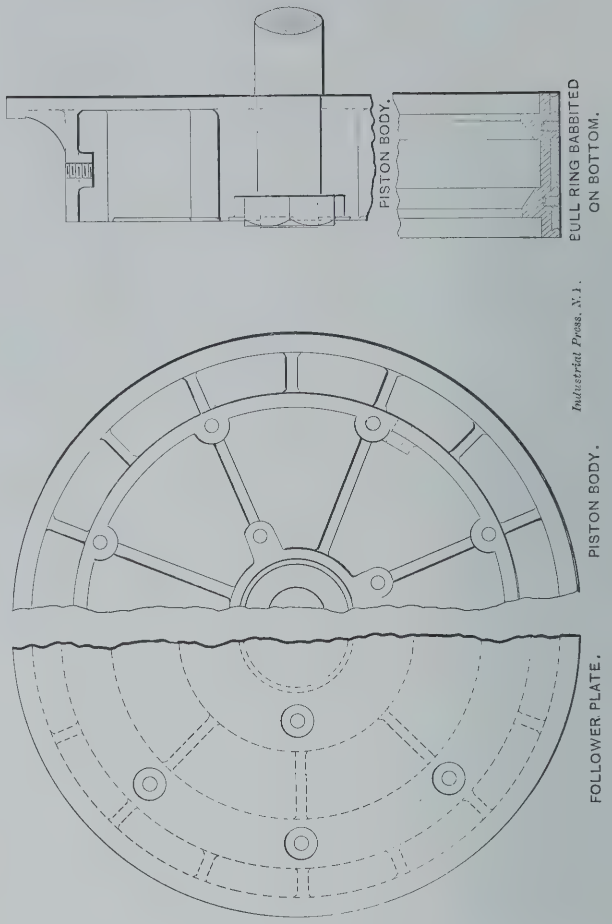
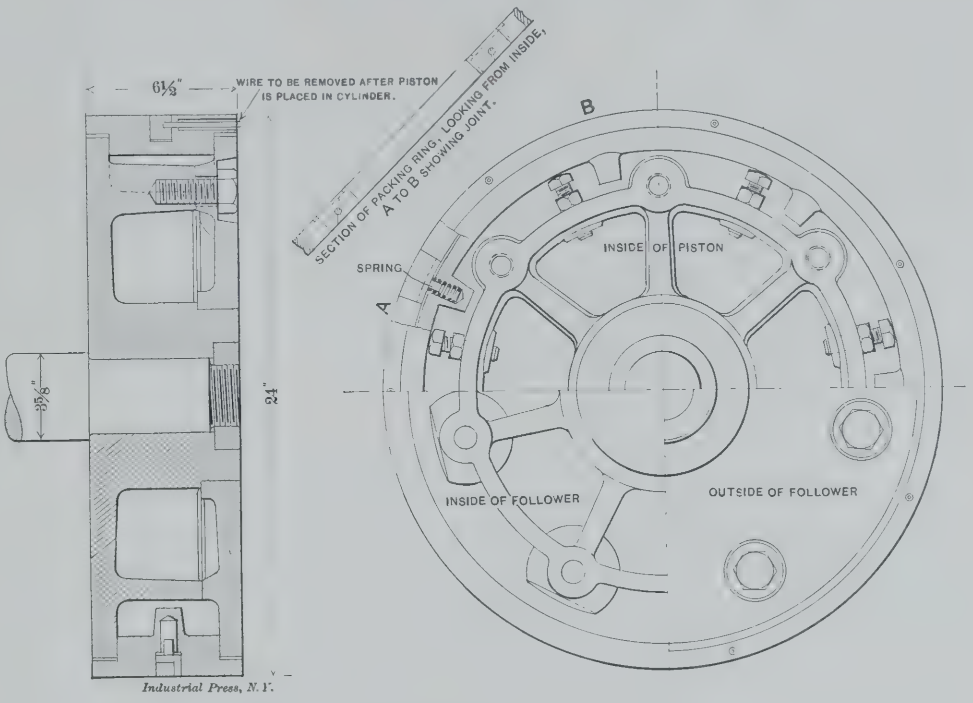


Fig. 4. Piston of the Fitchburg Steam Engine Works.

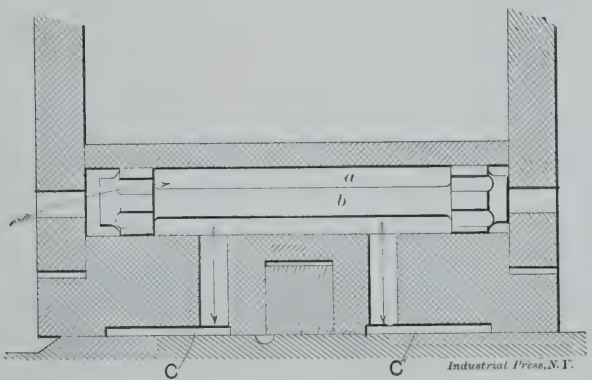
bull ring be made with a cavity in the bottom of it, on each side of the packing-ring groove, each cavity equal in area to one-fourth of the entire area of the cylinder in contact with the bull ring. Into both of the cavities in the bull ring live steam is admitted through holes, as shown in Fig. 6. Referring to this figure it will be seen that there is a cylindrical chamber in the bull ring, placed near the bottom of the cylinder, with a valve in it, slightly shorter than the distance between the flanges of the piston. Steam enters the chamber as shown by the curved arrow and passes into both cavities, *C*, as indicated by the vertical arrows. Now assuming that there is the same pressure in the cavities as there is on the piston (and there is no reason why this should not be very nearly the equal) and remembering that the unbalanced area of the bull ring is equal to that of the cavities, it is easy to see that only the inherent weight of the piston can rest on the cylinder. The cylinder may be relieved of a considerable portion of that, by increasing the area of the cavities.


6½"
WIRE TO BE REMOVED AFTER PISTON IS PLACED IN CYLINDER.
SECTION OF PACKING RING, LOOKING FROM INSIDE, A TO B SHOWING JOINT.
B
A
SPRING
INSIDE OF PISTON
INSIDE OF FOLLOWER
OUTSIDE OF FOLLOWER
3⅝"
24"

Industrial Press, N. Y.

Fig. 5. Piston of the Wm. A. Harris Steam Engine Co.

It will be noted that two counterbores are shown at the end of the cylinder in Fig. 6, one for the piston and one for the packing ring. It is quite possible that if Prof. Sweet's limited expansion packing ring is used, no counterbore will be needed for it, there being practically no ring wear on the cylinder. Then, too, without a counterbore to drop into, Corliss or snap rings may be made as narrow as it is practical to make them, for all diameters of cylinders, when the cylinder wear due to the ring will be so small that it may be neglected in properly cared for stationary engines. To illustrate this point take a 24 x 48-inch cylinder, with one packing ring in the piston ½ inch wide, the iron in ring and cylinder to be as nearly alike as possible, then we may expect the cylinder wear to be practically one per cent. of that of the ring. The ring in wearing away 2-10 of an inch in diameter, would raise a shoulder in the cylinder 1-1,000 inch high. It is a question, no doubt, among builders of horizontal engines, in regard to the advisability of supporting their pistons on a tail rod. Higher speeds and steam pressure add to the actual weight of the piston, to increase its strength, and also a greater steam load to carry; and yet it ought not to require an expensive and cumbersome excrescence like a tail rod, to solve the problem with equal satisfaction. I am well aware that "traps" in a piston or anywhere, except to play with, are very objectionable, but I do not believe that one moving piece, and a few extra holes, can possibly be a detriment to a piston, while its cost, convenience, appearance and maintenance are not to be compared to a tail rod. In regard to efficiency, I can only say that I have not had a piston like that in Fig. 6 in use long enough to determine that point.



Industrial Press, N. Y.

Fig. 6. Special Type of Piston.

A. L. Ide & Sons, Springfield, Ill., build two horizontal engines from 5 to 24 inches in diameter, and use a single piece piston and snap rings. I quote from their catalogue, page 59:

"The piston is a single hollow casting, very light, and so braced as to have ample strength. The packing rings are two in number, of cast iron, turned larger than the cylinder and sprung into place in the manner of a snap ring. The ends of the rings have lap joints which remain steam-tight, however much the rings may spring out from wear. The simplicity and reliability of this type of piston and packing are such that its adoption by engine builders has been universal." This last remark will cause the builders of Corliss, or the original Dunbar pistons, to wonder "where they are at," and those fellows who have had large experience in using packing rings will smile audibly when they read that a snap ring won't leak when it is worn out.

The Reeves Engine Co., of Trenton, N. J., build horizontal and vertical engines, simple and compound, from 2½ to 32 inches in diameter, and say of their pistons at page 22 of their catalogue: "The pistons are of cast iron, thoroughly ribbed and braced, thus getting rigidity with a minimum of weight. They carry self-adjusting packing rings, and will run a long while without special attention." That statement seems to be "above suspicion."

* * *

Where high speed lathe tools show signs of brittleness, try reheating at the same heat as before, but instead of cooling in the air or in an air blast, bury the nose of the tool in ashes on the forge for a minute or so and then cool in the air.—*Sparks from the Anvil.*

* * *

To file a circumferential groove in a round bar so that it will be a fair approximation to one turned in the lathe, is not an easy matter for the skilled vise hand. A correspondent to the *Mechanical World* shows a little kink for doing such a job that should be useful to know. He secured a block of wood in the vise, which has a V-groove cut lengthwise in the top. The groove is cut in the wood to such a depth that the bar lies well below the surface of the wooden block. Another groove is cut across the block at right angles to the first. This is to guide the file. The iron bar having been laid in the first groove, the file is passed across it using the second groove as a guide. The bar is supposed to turn, but slower than the velocity of the file so that the latter cuts a groove of even depth all around and at all points in the same plane.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Well preserved iron girders and beams are exhibited by the floor framing of a building, now being demolished, at the corner of William street and Exchange place, New York city. This building dates back of the Civil War. It has brick walls faced with marble, and floors of earth filling on an all-iron framing. It is noteworthy that the beams and girders show only spots of rust, the general surfaces showing either the original paint or, where the paint has scaled off, the oxide scale of the rolling mill. What say the corrosion howlers to this?—they who predict rapid deterioration of our steel structures, through rusting away.

Joseph L. Ferrell, of Philadelphia, has been awarded the Elliot Cresson gold medal by the Franklin Institute for his wood fire-proofing processes. These refer to means for impregnating raw lumber, the treatment of wood structures superficially and the fluid used for saturating, the base of which is sulphate of aluminum. By the ordinary impregnating process from 24 to 36 hours are required to saturate white pine boards; by the Ferrell process 15 minutes is said to be sufficient. When applied to the interior of finished buildings it does not interfere in any way with the use of varnish, etc., but has the remarkable effect of preventing "varnish flash" and making the surfaces fireproof.

It is reported that when water was turned into the great Sault Ste. Marie power canal, which has cost several millions of dollars, it was discovered that the piles supporting the large power house are underlaid with quicksand. In order to save the structure from undermining it was necessary to shut the water off and discontinue the informal test that was about to be made. The indications are that very extensive work will have to be done in strengthening the foundations, and it may be that the power house will have to be rebuilt. If true, some one has blundered seriously, as borings should have been made to considerable depths to ascertain the nature of the sub-strata before erecting thereon an expensive and important hydraulic power house like the one in question.

At the close of the annual commencement lecture at the Worcester Polytechnic Institute, there was an interesting experiment illustrating the trend of electrical engineering. The 500,000-volt transformer of the school, located in the high-potential laboratory, about 1,000 feet distant from the lecture room, was supplied with current taken through instruments on the lecture-room switchboard. This transformer was adjusted by the lecturer so as to deliver a potential of 120,000 volts, at a frequency of 60 cycles per second to a line of iron wire leading to the lecture room, where, on wires which were so small as to be invisible to most of the audience except when the room was darkened, the current was conveyed to another transformer of the electrical-engineering department, which stood beside the lecturer. This second transformer served to reduce the pressure to a value which could be applied to the primary of a rotary converter of about 10-horse power capacity located on the lecture table. This rotary converter was synchronized and operated from the line and ran with a load of incandescent lamps on the direct-current secondary. The experiment was especially interesting, as it was probably the first time that power has actually been transmitted at so high a pressure as 120,000 volts.—*Western Electrician.*

Machinery has been built by the Bethlehem Steel Co. for the manufacture of the Schoen solid forged and rolled steel carwheel, which is of a very massive and interesting nature. In making carwheels by this process a circular steel ingot about 24 inches diameter is cast for each wheel, which is of a quality that has proven, in steel tires, to be the best for the peculiar service to which a carwheel is put. The ingot is forged under a hydraulic press of special design which forms the hub, reduces the thickness of the web and increases the diameter to about 28 inches. The hot blank then goes to a special rolling mill where it is embraced by six rolls, two on the tread and four under the rim and against the web. Here the blank is rolled to the standard diameter of 33 inches. From the rolling mill the wheel goes to double-acting hydraulic press where it is coned and dished so as to bring the edge of the rim in proper alignment with the hub. This press is capable of exerting a pressure of 5,000 tons. The rolling mill occupies a floor space 22 feet wide by 40 feet long and requires a 1,000 horse power reversible engine to drive the rolls. Three electric motors are provided to drive the feed of the rolls. These may be worked independently or simultaneously by the operator. When the proper thickness of the wheel is reached the feed automatically throws out.

One of the interesting phases of the use of the steam turbine is utilizing the exhaust of reciprocating steam engines at about atmospheric pressure and in turn exhausting into a vacuum. There are many classes of work in which the steam turbine can never be expected to successfully displace the reciprocating steam engine because slow rotative speed and positive instantaneous control in either direction are of more importance than the mere matter of economy or simplicity. This is the case notably with hoisting engines used in mines. But if the exhaust steam from such engines can be profitably used for driving machinery requiring steady motion, well and good. For this purpose the steam accumulator was designed by Prof. Rateau some years ago, by which the exhaust from intermittently operating engines can be stored and effectively used in steam turbines exhausting into a vacuum. A notable installation of the Rateau accumulators is that at the Bruay mines in France. The accumulator consists essentially of a large vertical cylinder built of boiler steel in which are placed heavy shallow cast-iron trays separated by narrow spaces through which the exhaust steam from the reciprocating engine must pass. The accumulator acts both as a condenser and as an evaporator. The exhaust steam at slightly more than atmospheric pressure condenses and collects in the form of water when the supply from the hoisting engine exceeds the demand of the turbine. Then, as the engine stops, the water re-evaporates as the pressure falls and keeps up a continuous supply to the turbine.

The plans for the third suspension bridge to be built across the East River at New York, and to be known as the Manhattan Bridge, have been the subject of much criticism, owing to the projected use of eye-bar cables instead of wire cables, as in nearly all suspension bridges. A committee of engineers, however, have rendered a report entirely favorable to the plans as drawn. They state that eye-bar chains were used successfully long before wire cables were in use and that the chains have decided advantages in the accessibility of all parts for inspection and protection, as well as in economy and rapidity of erection; they are to be preferred to wire cables whenever the cost of the chains is not materially greater. The cost of eye-bar chains and wire cables in this bridge would be about the same.

The Manhattan bridge will be a suspension bridge, having a central span 1,475 feet long between centers of towers, and two side spans of equal length, each 725 feet long, measured from center of tower to anchorage connection. Both central and side spans are somewhat shorter than the corresponding spans of the old East River bridge. The general design consists of four cables supported by steel towers or bents, each cable being a steel eye-bar chain, hanging in a vertical plane. The two center cables are 40 feet between centers and the side cables 28 feet between centers, making the total width 96 feet between centers of outside cables. Each tower or bent consists of four vertical posts, one under each cable, these posts having pin bearings at the bottom, the pins being carried on metal shoes of sufficient size to distribute the weights properly over the masonry.

One of the most important works accomplished by the National Bureau of Standards at Washington has been the standardization of thermometers as manufactured by different concerns in this country. Some time ago sample thermometers were asked of the various manufacturers by the Bureau and it was found upon investigation that they varied in some instances by as much as three degrees—a very critical amount in the temperature of a fever patient. The manufacturers have now all consented to adopt the government standard and if their thermometers are carefully made they will all register alike.

This is one of the things that the Bureau of Standards has done since it was established. Another important work is testing delicate weighing machines used in chemistry, pharmacy and the sciences. It is desired to get manufacturers of measuring and weighing machines to work from precisely the same standard of weights or measures so that all such apparatus will give uniform results.

Another practical work that the Bureau is carrying on is in getting makers of machinists' tools to work from one standard of measurement so that all such tools will be exactly uniform. We imagine, however, that no marked variations in standards will be found here, for machinists' tools run very uniform as a general thing.

Before long the bureau will be established in a specially-constructed building on a hill near Washington, where the delicate instruments will be removed from the influence of noise and electric currents. In this new building there will be rooms where the temperature will be kept exactly the same the year around, and there the work will be carried on to greater advantage than is now possible.

A. A. Knudson, at the annual meeting of the American Electro-Chemical Society, stated: During an examination in a city for electrolysis of water pipe our attention was called by the Superintendent of water works to several water meters which he believed had been ruined by electrolysis caused by railway currents. After making careful tests at locations where these meters had been in use, and not finding any signs of railway current, we had one of them taken apart for closer inspection. We found in the interior a brass valve arranged to move over iron slides, the slides being a part of the iron frame of the meter. Suspecting galvanic action, we made an effort to measure the voltage, and selecting a meter that was not so damaged as to entirely prevent its working, we connected the brass valve with an insulated wire leading it out through the discharge, thence to the millivoltmeter. Another wire from the iron casing was connected to the opposite pole of the instrument. We then turned on the water from a service tap and allowed the meter to work the same as in practice; the effect was instantly shown upon the millivoltmeter which registered from 0.004 to 0.008 volt; variations of the needle between the minimum and maximum were caused by the variations of contact between the brass valve and the iron guides, over the uneven surface; the water was slightly brackish. The iron case was positive to the brass valve; the interior iron parts were softened and broke away. The number of this meter was taken, and the records in the office of the Water Department examined to see how long it had been in use, which was found to be about twelve years; from this data we make the following deduction: A water meter or other like instrument constructed with dissimilar metals such as brass valves running upon iron guides in brackish water with an average difference of potential of 0.006 volt, will in twelve years be ruined by electrolysis due to galvanic action, and register inaccurately in a much shorter period. It is but proper to say that water meters of this construction have long since been changed by the manufacturer, and those now made by the same firm are differently constructed and are not liable to galvanic action in their working parts. Other instances of the use of dissimilar metals in various other constructions could be mentioned, such as in steam plants, but we assume that sufficient has been said to at least call attention to the evils which may result from the use of dissimilar metals in contact with liquids wherever they may be placed.

RE-ENFORCING PADS FOR BLOW-OFF PIPES.

A writer in the *Locomotive* calls attention to the right and wrong ways of attaching re-enforcing pads to steam boilers for the blow-off pipe connection. These pads are usually made somewhat thicker than the shell plates, and are riveted to the boiler to strengthen the portion weakened by the hole cut for the pipe. But there is no good reason for not using the metal of the shell to hold the pipe, since tapping through both nearly doubles the length of thread. Therefore the method shown in Fig. 1 of attaching the pad, or rather of cutting the hole, is wrong. The hole in the boiler shell is cut so much larger than the outside pipe thread diameter that it can do no good toward holding the pipe in place. The right way to apply a blow-off pipe re-enforcing pad is shown in Fig. 2. The hole in the shell is made such a diameter that a full thread can be tapped. Both the thread in the shell and in the pad are, of course, tapped at one operation.

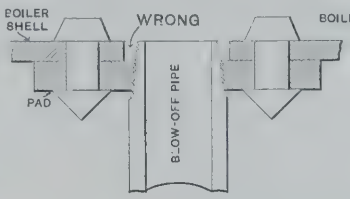
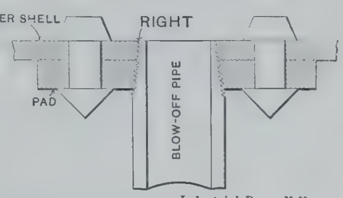


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

TREATMENT OF LEAKS IN CONCRETE WITH OIL.

Insurance Engineering, June, 1903, p. 539.

From the report of the Chief of Engineers, U. S. Army, 1902, it is learned that in the fortification work at Fort Caswell, North Carolina, it was found almost impossible, with the unstable subsoil, to prevent unequal settlement and consequent cracking of concrete. It was noticed that water falling on the concrete surfaces near the guns, which had been coated with the oil used on the guns, was not absorbed, and this led to a coating of the entire concrete mass with boiled linseed oil. Where large breaks occur, they are filled with cement grout, and the linseed oil is poured in as long as it is absorbed. There is formed in the crevice a gum from the oil which in time fills it to the top, after which the entire surface is coated with successive applications of the oil until it ceases to be absorbed. Previous to the trial of this method the two 12-inch emplacements were noticeably leaky, and for the purpose of experiment the worst of the two was selected and treated as above outlined, with the result that it was made perfectly water-tight. Since then all of the emplacements of the post have been treated in a similar manner, and may now be considered water-tight. It is thought probable that it will be necessary to give a coating of oil, at least near the openings, when the concrete expands and contracts in the spring and autumn, but this will be comparatively inexpensive and take very little time.

APPARATUS FOR WASHING MOVING TRAINS.

Railway and Locomotive Engineering, July, 1903.

A novel train washing apparatus is in operation on the Great Western Railway at the West London yards. It consists of a small shed built over a single track and through this a yard engine draws a train at the rate of about four miles an hour, and it comes out of the shed as clean as a good rubdown and cold water can make it.

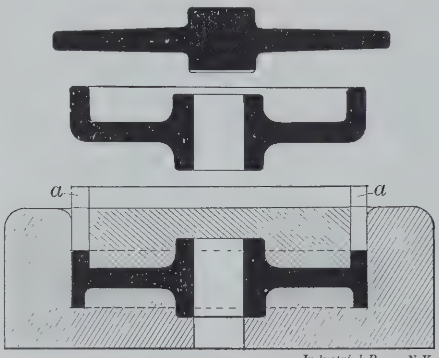
On each side of the shed on a movable frame there are arranged brushes which are made to revolve rapidly and beside these brushes there are perforated water pipes which when the apparatus is in action, give a copious discharge of water. The whole is operated by steam power, and the men employed in the washing of cars stand behind glass screens which keep them from getting wet. By the manipulation of levers, the revolving brushes are brought against the sides of the coaches. There are water pipes on each side of the brushes, so that if by any chance the brushes should leave streaky patches the Niagara flow washes it off.

The brushes are on shafts driven by chain gear and sprocket wheels, so that water has no effect upon them, and the track is arranged to drain the water off as rapidly as it falls. Something less than a thousand coaches are thus given their "tub" every day with thorough English regularity, and the railway company has found the washing shed to be a time and labor saver. The plant is the property of the Universal Carriage Washing Syndicate of London.

DISK AND SPOKE WHEELS.

Zeitschrift fur Werkzeng Machinen und Werkzenge, April 15, 1903, p. 297.

By means of a new process brought out by Ernst Römer at Gleiwitz, wheels and pulleys, applicable to a great variety of purposes can be formed out of steel castings. The raw material required consists of a blank either with a full or hollow hub as shown in Fig. 1, and formed into the rough shape either by hammering or casting. These blanks are then heated and brought into the shape indicated by Fig. 2, between dies worked either under a hammer or a powerful press, by which the rim will be turned back and made symmetrical on each side of the disk or spokes. This latter formation is effected either at the same or a subsequent heat by means of the hollow stamp, *a*, Fig. 3, whereby a uniformity and proper distribution of the thickness of the metal is brought about. G. L. F.



Figs. 1, 2 and 3.

HOISTING FROM GREAT DEPTHS.

Engineering and Mining Journal.

In the course of a review of a paper read by H. C. Behr on "Winding Plants for Great Depths" Robert Peele says that the variation of load moment on a hoisting engine due to the varying weight of the rope, is enormous. The best steel is used for the ropes of deep shafts, being plow steel having a tensile strength of from 200,000 to 250,000 pounds per square inch. But even with the high average tensile strength of 250,000 pounds a rope 1.52 inches diameter is necessary for hoisting a net load of 8,000 pounds in a skip weighing 5,000 pounds from a depth of 6,000 feet. A wire rope of this size and length, weighs 22,500 pounds, and with the skip and contents weighing 13,000 pounds, the load varies from 35,500 pounds at the bottom to 13,000 pounds when the skip is at the top of the shaft. To compensate for this variation of load conical winding drums are employed, but there are practical difficulties in using perfectly compensated conical drums for very deep shafts. From the principle of the conical drum it is obvious that while the difference between the end diameters of the drum increases with the depth of the shaft (or the length and weight of the rope), the axial length of the cone does not increase proportionately to the diameter of the larger end. In other words, if the end moments be made equal, the angle which the element of the cone makes with its axis becomes excessive for a very deep shaft, which may lead to difficulty in properly fleeting the rope upon the drum, and even to a liability that the rope may slip from a groove, thus causing a dangerous shock or even breakage. For depths of less than 3,000 or 3,500 feet this difficulty is not serious, but for depths approximating 5,000 feet the angle of the drum becomes extremely steep, provided it is really designed to attain equalization. A case in point is the huge double conical drum of No. 3 shaft of the Tamarack Mine, which is 10 feet diameter at the small end and 36 feet at the large end, the angle of the cone being about 52 degrees. This drum is designed to hold 5,500 feet of rope on each side, the portion from 17 feet to 36 feet diameter being used for hoisting from 4,500 feet. Trouble has been experienced with the fleeting of the rope on this drum, and the maximum speed of hoisting is kept lower than at shaft No. 2, which is provided with a cylindrical drum 30 feet 6 inches in diameter. In Tamarack shafts Nos. 1 and 5, combination conical and cylindrical drums are employed. For a double compartment shaft the larger part of the drum is cylindrical, terminating at each end in a short frustrum of a cone. Each rope in turn winds up the conical surface and then over the cylindrical part, the latter being alternately occupied by the over and under ropes.

THE AUTOMOBILE AND THE RAILWAY AS TRANSPORT AGENTS.

Engineering Magazine, July, 1903, p. 481.

The author denies that the automobile can ever become a serious competitor to transport lines having steel rails to carry the load. While the automobile is undoubtedly destined for a much broader field of activity than it now enjoys, it must always remain a vehicle of pleasure and a means of freight transport for limited distances only. This applies to streets and roads covered with ordinary paving or macadam. The traction or pull of a vehicle on the best macadam road is at least four times that on steel rails; on some macadam roads it is eight times as great. The steel road is as much better than macadam as macadam is better than mud. A locomotive which cannot propel itself more than twenty-five miles an hour on the best macadam road, can pull a long train of cars at that speed on steel rails. Running cars on steel rails has changed the world more than any invention ever made, extending commerce, spreading civilization, promoting peace, unifying nations. That it is the steel rail more than the locomotive that has worked these great changes is shown by the fact that the locomotive at work off of steel rails has accomplished very little, although it has been in actual or attempted use longer than the locomotive on rails. Railways without locomotives, such as horse-railways and cable-railways, are able to carry passengers three or five times as far for a nickel as any vehicle on any other kind of road. In the first case the railway is maintained by the transportation company, and in the second case the road is maintained by the taxpayers and is entirely free to all users. The average cost of hauling freight by road locomotives is at least ten cents per ton mile; on the Pennsylvania Railroad it is only one-half cent. It is one of the great disadvantages of vehicles not on steel rails that they must be steered around each other, thus pursuing a serpentine course which adds to the distance and makes high speed dangerous. Sixty miles an hour is safe on rails; fifteen miles an hour is dangerous on macadam. Again, a dollar's worth of steel will probably outwear a dollar's worth of macadam. The life of a traction engine is only four or five years; that of a locomotive is fifteen to thirty years. The automobile instead of becoming a menace to the railway, will become a feeder to it. Its efficiency will be greatly increased by the laying of plate rails, but it then becomes a locomotive traveling on a railway. The steel plateway for city streets cannot become a great success for automobiles until they become so numerous that the horse is practically banished as a factor in hauling a city's freight.

THE CUTTING ACTION OF HIGH-SPEED STEEL.

Abstract from Paper read by W. H. Maw before the Institution of Civil Engineers, June 16, 1903.

A few years ago the claim of this subject, "The Action of Cutting Tools," to be regarded as an "unsolved problem in engineering" might, perhaps, have been disputed, but in view of recent developments the matter has assumed a different aspect. The matters which have had the most important influence in bringing about the present conditions are two—viz., first, the extensive adoption of automatic machine tools; and, second, the introduction some three years ago of the so-called "rapid tool steels," capable of working under conditions previously regarded as impracticable. The use of automatic machine tools has accelerated materially the adoption of the system of employing, in machines, tools which have been ground to certain definite forms and cutting angles, which the man in charge of the machine is not allowed to modify. To secure satisfactory results under such a system it is evident that strictly definite knowledge is necessary of the form of tools required, as well as of the character of steel of which they are made and its treatment. What is required in such tools is not only good cutting action at high speeds, but also the power of maintaining the cut for considerable periods without requiring readjustments; and to enable these conditions to be fulfilled with the older classes of tool steel, very efficient lubrication or cooling of the cutting edge was essential. On the other hand, the new classes of "rapid tool steel," such as the Taylor-White steel and its successors, work well under quite different conditions; they can be run dry at exceptionally high speeds and under heavy pressures, and can, without injury, be allowed to attain temperatures which would at once ruin any ordinary steel. Now we are here brought face to face with an apparently utterly abnormal condition of things—a condition which is not only of high importance in itself, but of even greater importance as indicating how extremely limited is the knowledge which we possess of the materials available for our use. To what, then, is the action of these rapid steels due? This is a point which has as yet been far from fully investigated; but experiments have been made by Mr. J. Spüller, the chemist, and Messrs. Whilacek and Hatlanek, engineers, of the Poldihütte, Kladno, which, together with the researches of Mr. Fridolin Reiser, of Vienna, throw considerable light on the matter.

The new tool steels contain in addition to iron and carbon —chromium, tungsten, and sometimes titanium and molybdenum, and Mr. Spüller's view is that, in the point of the tool, the excessive heating causes a portion of the carbon to leave the iron and form high carbides of chromium and tungsten. These higher carbides exist in the form of needle-like crystals of intense hardness, which are embedded in the soft iron carbide as in a matrix, and which form the real cutting portions of the tool. This view is supported by the fact that the points of these tools harden in use, and also by the form assumed by the tool points after heavy service; but it cannot be said to be absolutely proved, and the assumption that the formation of the crystals of chromium and tungsten carbides is due to the heating alone does not seem to satisfactorily explain the difference which apparently exists between the point and the immediately adjacent portions of one of these tools. There is, however, another action going on which may, I think, exert an important influence, and that is the extremely intense pressure to which the point of such a tool must necessarily be subjected. Of course, this is merely a suggestion, but I think it not improbable that further research may show that intense pressure and heat in combination can produce an effect which would not result from heating alone.

THE EFFECT OF VACUUM ON THE STEAM TURBINE.

Power. July, 1903. p. 400.

The steam turbine is very sensitive to a vacuum. A couple of inches additional vacuum will increase the efficiency of a turbine much more than it would that of a reciprocating engine. It is easy to see why this should be so. In the reciprocating engine of the most refined type more than twenty expansions are rarely used, usually less. In the steam turbine one hundred expansions may be easily realized. Conceive of a steam diagram with twenty expansions. If the counter pressure could be lowered two pounds, an area would be added to the diagram equal to the product of the width representing that pressure and the length of the diagram. Suppose now the number of expansions be increased to one hundred. Since the length of the diagram represents the final volume, the diagram would be five times as long and the lowering of the counter pressure line two pounds would add five times as much area as it did in the former case. In addition to this area, another gain is derived from the further expansion.

With equal ratios of expansion, as where both engines exhaust against a pressure of, say, five pounds above the atmosphere and the reciprocating engine diagram ends in a point, the turbine will probably be less efficient than the reciprocating engine. The turbine owes its efficiency to the large ratios of expansion which it can utilize and even with these ratios is able to attain efficiencies only equal at best to those of the best piston engines. The reciprocating engine suffers some 20 per cent. from internal condensation, due to the alternate heating and cooling of its surfaces. The turbine suffers probably more from lack of mechanical efficiency. When steam is confined its pressure is positively exerted upon the containing surfaces and any increase of volume is positively productive of the corresponding amount of power. In the turbine the energy of the steam is first put into inducing motion in the jet or current and then the turbine is used to absorb it. This it can do perfectly only by bringing the steam to absolute rest, and in the absence of eddy currents and friction. The best water turbines convert only about 80 per cent. of the energy of the water, and probably the steam turbine is no more efficient as a turbine, so that whatever advantage the turbine may have over the reciprocating engine in the avoidance of internal condensation is probably offset by its lack of efficiency as a motor.

Another reason why the vacuum is of particular value to a turbine is the reduction which it effects in the windage. A top will spin for an enormously long time in a vacuum. If it had to spin in an atmosphere of compressed air or high-pressure steam, its motion would last for a comparatively shorter time. At the high speed at which the turbine vanes are run the frictional resistance in the dense high pressure steam of the earlier stages must be considerable, but in the much less dense atmosphere of the later stages much less of the energy absorbed is used in overcoming friction. Of course energy cannot be continuously imparted to steam in a confined space without heating it, so that the heat developed by this and other forms of fluid friction may go to improving the quality of the steam and preventing its condensation.

Since the turbine is less efficient than the reciprocating engine in the early stages of expansion, but is capable of carrying the expansion practically to so much greater an extent, the idea suggests itself that the turbine might be used to replace the low-pressure cylinder of a compound engine. This would mitigate the loss from internal condensation, as all the heat which goes into the first cylinder, with the exception of that lost by radiation and converted into work, must pass to the receiver and would be available for use in the turbine through the lower temperature range. Great ratios of expansion would be available and the enormous cylinders necessary for even the limited ratios now attained would be avoided. The simplicity and compactness which are such attractive features of the turbine would be, however, in a measure sacrificed, as would the particularly advantageous use of superheated steam and the avoidance of oil in the condensed exhaust.

THE HEISLER COMPENSATING GEAR FOR DIRECT-ACTING PUMPING ENGINES.

Engineering News, June 4, 1903, p. 497.

Chief among the defects of direct-acting pumping engines are the variable length of stroke, inability to run at high speeds, and unsatisfactory steam distribution, leading to poor economy. Crank-connected pumping engines overcome these defects, but only at the expense of lightness and low cost. In direct-acting pumps the resisting force in the water cylinder is constant throughout the stroke and is equal to the delivery head of the pump; the steam pressure must, therefore (neglecting the inertia effects of the moving parts), also be constant. In other words, full steam pressure must be used throughout the stroke. The advantage of steam expansion is therefore lost and the pump is very wasteful of steam.

The inertia of the moving parts tends to correct this evil. They absorb energy during the first part of the stroke in the acceleration of the mass of the pistons, rods, etc., while the last part of the stroke these masses being brought to rest give up this stored energy. Therefore, instead of a constant steam pressure being required throughout the stroke it is necessary that the pressure during the first half of the stroke be higher than the average, and lower than the average during the latter part of the stroke. If the reciprocating parts be made very massive this effect may become large enough to permit of quite early cut-off. This method has rarely been employed, however, because of its expense, although in the

D'Auria pump a column of water, contained in a closed circuit of pipe, is substituted for the heavy metal reciprocating parts. Another method originating with Mr. A. S. Cameron has been used in modified form in the Worthington high-duty pumping engine, in which there are auxiliary hydraulic cylinders attached to the piston rod in such a manner that they force water into an accumulator during the first part of the stroke and during the second half of the stroke the plungers in these cylinders are driven by the pressure water stored in the accumulator.

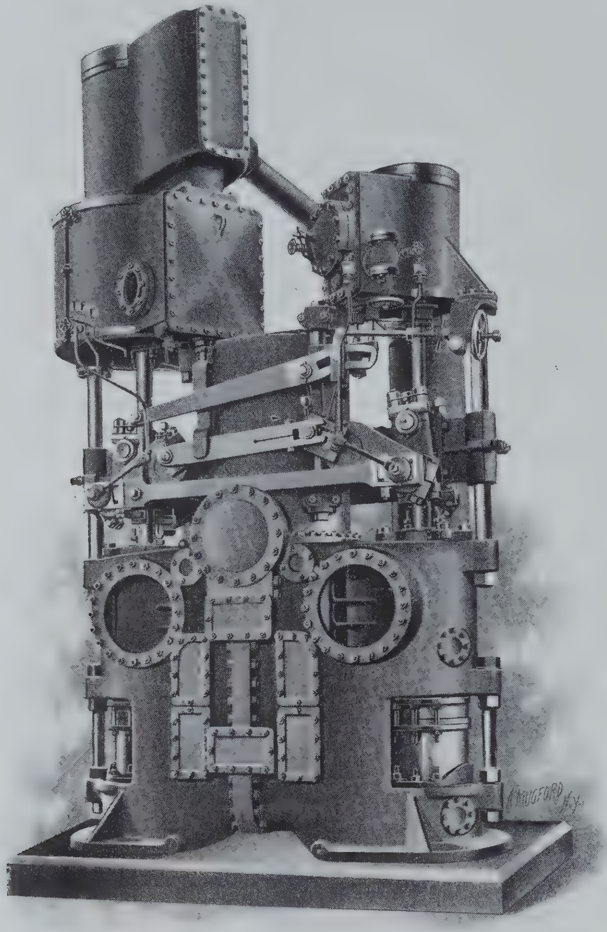


Fig. 1. Triple-expansion, Direct-acting Heisler Pumping Engine, with Compensating Mechanism.

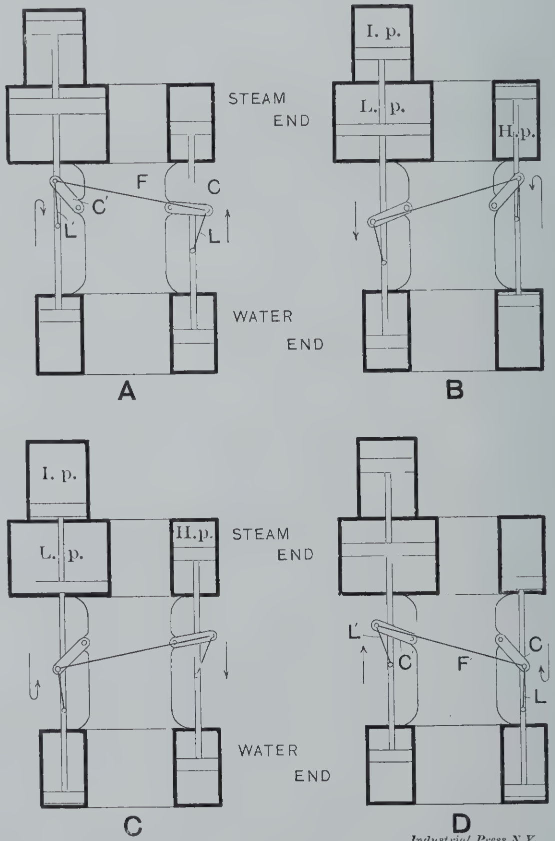
A few years ago Mr. Charles L. Heisler devised a direct-acting pump in which compensation is secured by novel means, different from any of the foregoing. His construction comprises essentially a link connection between the two piston rods of a duplex or compound pump. By means of this linkage the steam cylinder of one side during the first part of the stroke gives aid to the other side, which is then in the last part of its stroke, and in turn when near the end of its stroke it receives aid from the other side. The linkage also gives each of the two pistons a definite, fixed length of stroke in place of the undetermined and variable stroke of the ordinary pump. As a result clearance spaces may be made small and a smooth action is obtained at all speeds.

In Fig. 1 is a general view of a large size Heisler engine which illustrates the general arrangement of the mechanism. It has a triple-expansion steam end direct-connected with two water cylinders. The intermediate and low-pressure cylinders are set tandem, together with one of the water cylinders, while the high-pressure cylinder is set in line with the other water cylinder. The engine has a capacity of 10,000,000 gallons per day. The steam cylinders are 21, 33 and 48 inches by 24 inches stroke, and the pump plungers are 19 inches diameter.

The "compensating" linkage is seen in Fig. 1 between the steam and water ends, and consists of two functionally separate parts: The compensating linkage and the valve gear. Since the former is the essential novelty of the pump it will be explained first by the aid of Fig. 2.

The device consists of two crank arms, *C* and *C′*, pivoted to the frame casting of the engine, and having their free ends connected with the piston rods by links *L* and *L′*; the free ends are also interconnected by a rod, *F*, which has no fixed attachment to the frame and is called the floating rod. The piston rods of the two sides of the engine being thus linked together, they have definite relative motions, and any deficiency in moving force on the one side will be made up by aid from the other side. The relative positions of the two sides at four different points of the stroke are shown in Fig. 2. At *A* the low-pressure side has just completed its up-stroke, and the high-pressure side has traveled about one-third of its stroke from the bottom; the former has an excess of moving force during the first part of its stroke and aids the high-pressure side during the remaining two-thirds of its stroke. At *B*, the high-pressure piston has completed its up-stroke under continuous aid from the other side, and during the first third of its down-stroke its excess of moving force aids the low-pressure side in completing its stroke. It will be observed that the floating rod *F* is in tension throughout the conditions *A* and *B*. At *C* and *D* are shown the respective positions one stroke later than *A* and *B*; evidently the action is the same as that described; the low-pressure side during two-thirds of its up-stroke aids the other side, and the latter aids the low-pressure only during one-third the stroke.

As shown in Fig. 2, the low-pressure side leads the high-pressure by about two-thirds of a stroke. With this arrangement it is clear from the preceding description that the high-pressure side receives more aid than it returns; it has the benefit of the high initial moving force on the low-pressure side during two-thirds of its stroke, while it in turn aids the low-pressure only during one-third its travel. This makes it possible to employ a very early cut-off in the high-pressure cylinder and thus secure economy in steam consumption. If the direction of motion were reversed, the above relation would also be reversed, and in this case the low-pressure side would receive more aid than it gives.

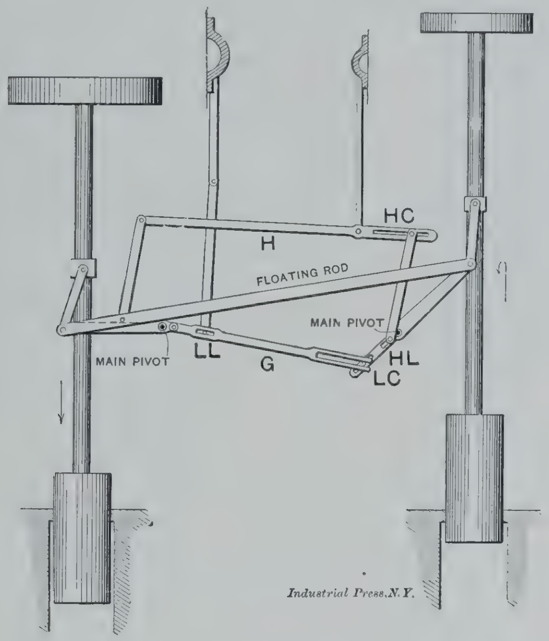


Industrial Press N.Y.

Fig. 2. Diagram of Compensating Linkage and Valve Gear.

In connection with this compensating linkage Mr. Heisler usually employs a peculiar valve gear, which takes its motion from the links of the compensating motion. The purpose of the gear is to secure rapid opening and closing of the valves by an action which shall operate smoothly at all speeds. In Fig. 3 is shown a compound pump, the high-pressure cylinder being on the right, fitted with compensating links. The tail of each crank arm of this linkage is extended to give an attachment for the valve-gear links. From this point of the low-pressure crank arm a lever, *G*, extends over to the high-pressure crank arm, in whose tail is fastened a pin on which lever *G* slides. This pin can be moved toward or from the crank arm center for the purpose of adjusting the point of cut-off in the low-pressure cylinder. At *L L*, on the lever *G*, the low-pressure valve stem is fastened by means of a link. The high-pressure valve is connected in a similar way to a lever, *H*, which at one end is linked to point *H L* on the tail of the high-pressure crank arm. The other end of lever *H* is attached somewhat differently from lever *G*, being connected by means of a link to a point on the floating rod of the compensating linkage.

The motion of either valve is determined in the main by the motion of its piston rod, valve and piston rod moving approximately in opposition; but when the corresponding piston is near the end of its stroke, and is consequently moving slowly, the influence of the other piston becomes the dominating one, and it acts upon the gear so as to give the valve a rapid motion in this part of its travel.



Industrial Press, N.Y.

Fig. 3. Diagrams showing Operation of Valve Gear.

At the points marked *L L*, *L C*, *H L* and *H C*, the pins connecting the separate levers of the valve gear are adjustable, as indicated by the slotted holes, for the purpose of adjusting the amount of lead and the point of cut-off in the two cylinders.

DRAWING OFFICE EQUIPMENT—UNIVERSAL DRAFTING MACHINE.

Paper read by John B. McGeorge at Saratoga Meeting of the A. S. M. E., 1903.

One of the interesting and valuable papers presented at the Saratoga meeting of the American Society of Mechanical Engineers (June, 1903), was that by John B. McGeorge on drawing office equipment. Mr. McGeorge made a strong plea for better drawing office equipment and facilities than are usually provided. He said there are many prominent engineers who look upon drafting as merely a means to an end, and the end they seek is so much more important in their opinion than the means, that the drafting is too trivial to be given their attention. For the sake of comparison suppose a rolling mill is to be designed. Much attention is paid to the design, but the mill is merely a means to an end. Suppose that rails are produced by this mill—they are simply a means to another end—and so on indefinitely. It is estimated that from $45,000,000 to $50,000,000 is paid to draftsmen in this country in one year. In view of this enormous expenditure it would seem that the drawing office should receive more attention than it does and its equipment be such that it not only can produce drawings in the cheapest way possible, but also in the best way possible. To illustrate the "penny-wise-and-pound-foolish" methods of economy sometimes practiced, mention was made of the experience of a chief engineer who took charge of a large force of draftsmen. He found that the man who had been in charge was buying the cheapest kind of paper and the cheapest supplies that could be obtained. By this parsimonious practice he succeeded in cutting down the supply bill from $60 a month to $30 a month, making a net saving of $360 a year. But the salary item was $100,000 a year and to save $360 he was jeopardizing the $100,000 item, and probably losing from $10,000 to $15,000 a year.

Then again some engineers will state that they have draftsmen who can accomplish more with a short stub of a pencil, a cheap tee-square, and some old rusty instruments, than other men can do with the very finest equipment. This is very true, but it does not follow by any means that the first man would not accomplish more with a better equipment. There is still a great necessity to insist upon the truism that the best men in the best surroundings, and with the best conveniences, do the best work.

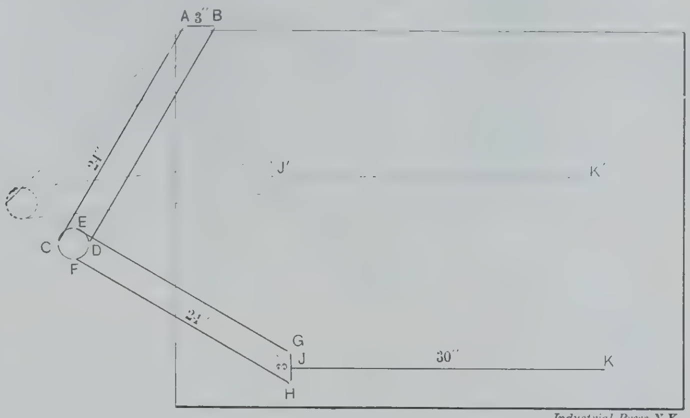


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Fig. 1.

"Our stenographers are supplied with good typewriters and nice desks, and our clerks with the best equipment that can be provided for them. In the shops we are anxious to put in all the labor-saving machinery possible, but in the drafting room, where salaries are very much higher and where any saving counts a great deal more, both directly and indirectly, it is very generally true that the equipment is often cut down to a deplorable extent. It certainly ought not to be so.

The first point to be considered in the equipment of an office is the question of light. Daylight is the best as well as the cheapest, but is not at all times obtainable. In large drafting rooms this light is not usually sufficiently diffused. The windows should be as high and as near the ceiling as possible, so that the interior of the room may receive light. The man next to the window should only have control of the shades covering the lower half of the sash, and the shades, both upper and lower, should be translucent. There are only two methods of artificial lighting which have proved to be perfectly satisfactory. The one is where arc or Nernst lights are used and the light reflected from them against dead white ceilings and walls. This gives good general illumination, which, if properly done, will dispense with individual lights. The other method, which has given satisfaction, is the individual adjustable electric lamp for each board.

Industrial Press, N.Y.

Fig. 2.

Another important consideration is that of ventilation. No draftsman can do his best work without an abundant supply of fresh air. This is a matter that is receiving more and more attention in the designing of schools and public buildings, and it is beginning to receive considerable attention in offices. A very practical question arises as to the number of square feet area to be given to each man. There are three factors entering into this question. First, the convenience of the draftsman, allowing ample room for reference drawings, etc.; second, ventilation; and third, sufficient room so that those supervising the work can get around the office without disturbing the men in passing. It is believed to be good policy to allow at least 100 square feet for each man. The American Bridge Co., employing hundreds of men, allows considerably more than this. In regard to the sanitary arrangements, the toilet room should be immediately off the drafting room instead of being in some inaccessible nook as is too often the case.

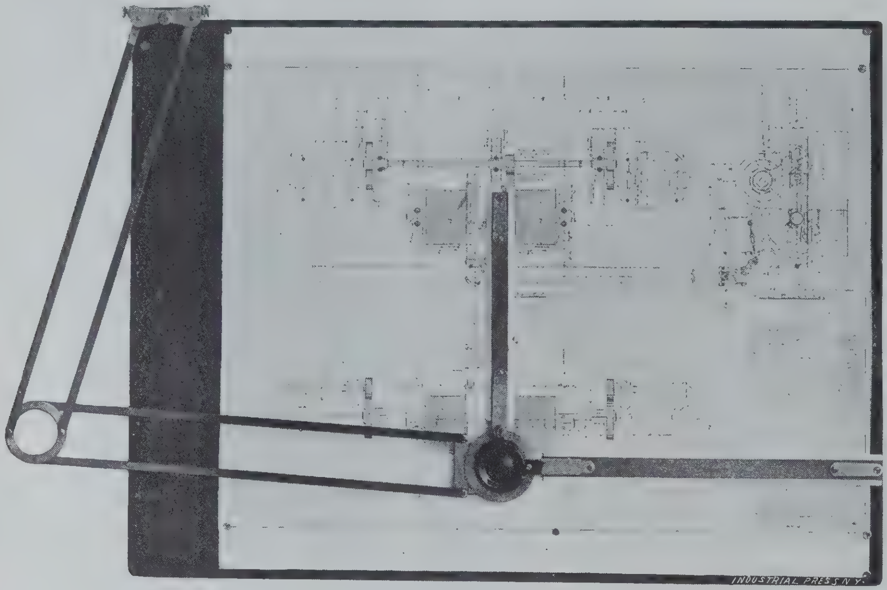

Fig. 3. Universal Drafting Machine.

The employers of the author, the Wellman-Seaver-Morgan Co., have been using a large number of Svenson boards, which have a frame carrying a parallel ruler on the Bergner principle, and in which frame can be placed a loose board, thus enabling a number of different drawings to be worked on without disturbing the paper on the board. The Svenson board can be placed at 60 degrees, 45 degrees, or flat (the ruler being balanced), and this to anyone troubled with bilious headaches is a great blessing. But several objections were found to the use of the vertical drawing boards for average size drawings, so later a table was designed which could be adjusted in height and slope and used in connection with the T-square or the "Universal" drafting machine. The objections referred to, are mainly three. Some of the men objected to holding their arms up about even with their shoulders all day long, and then again the vertical board does not give them opportunity to have their reference drawings and other data scattered conveniently around as does the horizontal board. The third objection is that of the superintendent who does not like to have the office divided off into stalls.

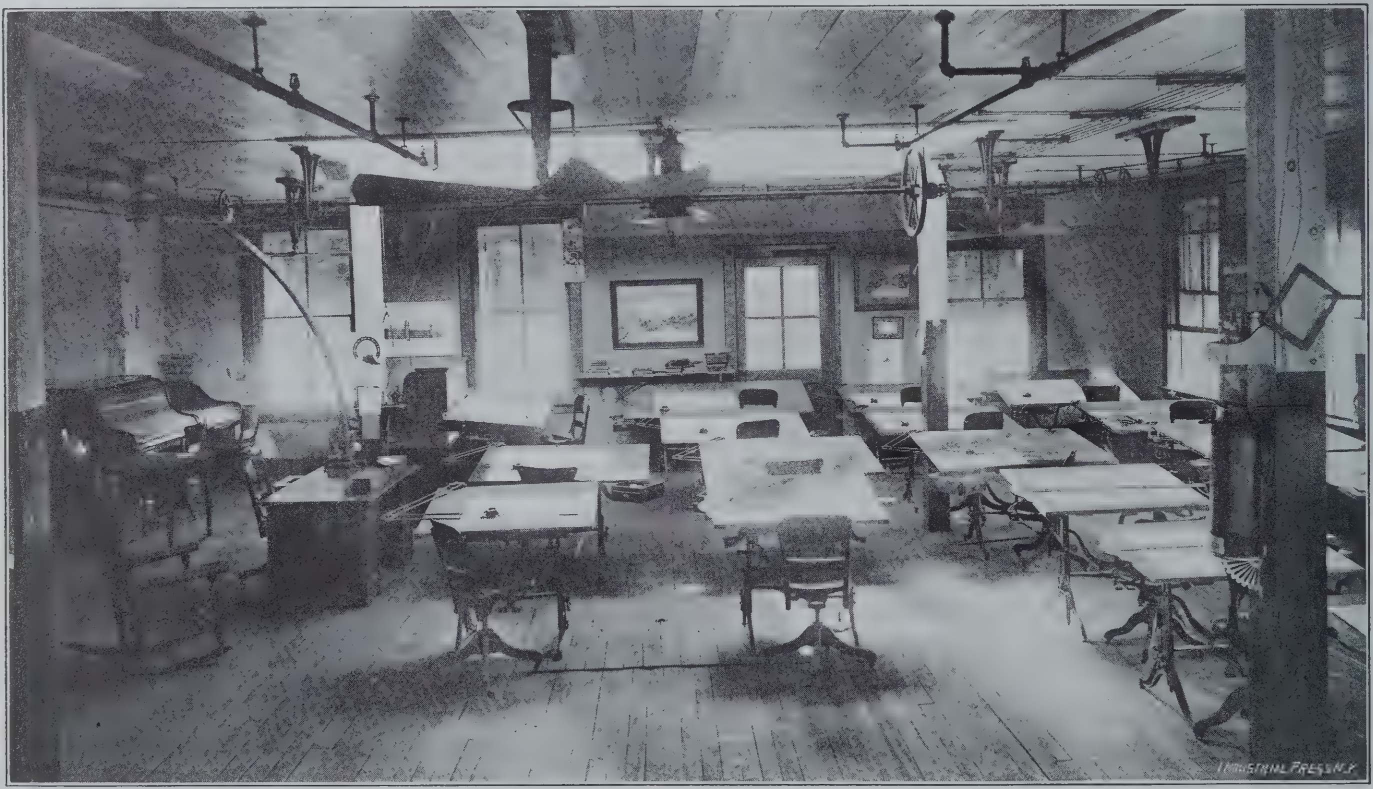

Fig. 4. Drawing Office of the Dodge Manufacturing Co.

The "Universal" drafting machine referred to is the invention of Charles H. Little, and was worked out by him while employed in the drawing office of the Wellman-Seaver-Morgan Co., where it first received practical trial. Fig. 1 shows the principle of the device in outline. It consists essentially of the two arms, AC and BD pivoted at one end to the corner of the drawing board and to a ring at the other end. Midway on the ring between the latter pivotal points are connected the arms EG and FH, which are connected at the other end by a third member upon which is mounted the straightedge JK. When the straightedge is moved to another position on the board, it remains parallel to its former position as indicated by the dotted line $J' K'$. The arms then assume the positions indicated by the dotted lines. The device is, in fact, a parallel motion in which the member AB is fixed. But the length of AB is only 3 inches, while the length of the arms is 24 inches and that of the straightedge is 30 inches. The first impulse of almost every practical man would be to say that the thing is unpractical to manufacture simply because it would not be possible to make it in numbers, of sufficient accuracy to meet the requirements of the draftsman. The cross-bars AB, CD, EF and GH, are all three inches center to center of the pivots. Any looseness in the bearings would be multiplied ten times out at the end K of the 30-inch straightedge JK. But as the practical variation found is only about 1-100 inch it shows that there is a looseness of only about 1-8,000 inch in each of the eight bearings, which indicates a degree of accuracy in machines made in numbers that is surprising. Another feature of vital importance is that all the arms shall be of equal length, otherwise the position *J′ K′* would not be parallel to that of *JK*. The arms should not only be of the same length, but they should also be straight and parallel with the board when in their working position, especially *AC* and *BD*. The first condition must be obtained by accurate "jigging," but the second condition is obtained by giving *AC* and *BD* an initial set upwards as indicated by the dotted lines in Fig. 2, which is a view of the device looking at the left end of the board. The weight of the ring and the other set of arms then brings these rods downward to a position parallel with the table. This is very important, as the sag of the arms in an instrument of so accurate construction, was found to be a most serious matter. The joints work on straight pins which are hardened and ground. A cone joint, adjustable for wear was first used, but this has been discarded as it was found difficult for the users to make the fine adjustments necessary for accuracy. They cannot tinker with the straight joint, and as soft, straight pins even have shown no perceptible wear after long use there is really no need for an adjustable joint, especially when the straight pins are hardened.

The photograph reproduced in Fig. 3, shows one of the machines mounted on a drawing board with two scales, also used as straightedges, mounted at right angles on the protractor head. The normal location of the stationary pivots is at the upper left-hand corner of the board. The drawing shown is that of an ore-handling crane drawn to the scale of 3-4″ = 1 foot. The horizontal straightedge is 18 inches long and the vertical one is 12 inches long. Both are reversible, clips being provided at both ends for engaging the connections mounted on the protractor head. The use of scales as straightedges is said not to be detrimental to them since the graphite of the pencils acts as a lubricant. The protractor is made with spring stops for the angles most commonly used; it may also be clamped at any required angle. With this feature it is obvious that angular work may be as readily done as ordinary work, *i.e.*, vertical and horizontal lines.

The drawing room illustrated in Fig. 4, is that of the Dodge Manufacturing Co., Mishawaka, Ind., which largely uses the "Universal" drafting machines, twelve being shown in the view. In other respects this drawing room conforms to the ideas set forth in Mr. McGeorge's paper. The lighting is unusually good, although perhaps as not as well diffused as it should be. Fans are provided for circulation of air in hot weather, and a pneumatic message tube connects it with all principal parts of the shop.

AN INDICATING ANGLEMETER.

Abstract from Paper read at the Saratoga Meeting of the A. S. M. E., June, 1903, *by C. E. Sargent.*

Ever since it has been desirable to operate alternating generators in parallel, the question of getting a prime mover the angular velocity variation of which shall come within the limits prescribed by the generator manufacturers, has been an important consideration. When Corliss engines were first used for incandescent direct-current lighting, many of them had such light-weight flywheels that an observer could count the revolutions of the engine by the variations in candle-power of the lamps. Generally speaking, the heavier the flywheel—other things being equal—the less will be the angular velocity variation during a rotation; but the heavier the flywheel the greater the first cost and the more power required to revolve it in its bearings; hence a flywheel just heavy enough to vary less than the maximum allowed is more economical than one of greater weight. In order to be able to determine at sight the actual maximum variation in steam-engine flywheels, and more expressly in the flywheels of internal combustion engines the instrument herewith described was designed.

If a light pulley is driven by the engine shaft with a flexible, inelastic belt, it should vary in speed commensurate with that of the engine. If a heavy flywheel at a high velocity is kept in motion by a tension spring having a practically uniform pull, there should be no change from a uniform velocity during a revolution of the engine. The device described indicates in circular measure the variation of the engine flywheel from a uniform velocity.

The anglemeter consists of a heavy main frame and base, and two uprights with bearings on each which carry the moving parts.

The shaft *A*, Fig. 1, to which the intermediate bevel pinion axis *D* and the segment *F* are rigidly attached. carries the flywheel and bevel gear *B*, the driving pulley *C* and the gear *E;* the latter are fastened together by the feather *I*. The rotation of the shaft *A* and the parts fixed to it, is limited by the stops *K*, Fig. 3. Motion of this shaft and segment *F* is transmitted to the pinion *G* and segment *F′* and the pinion *G′*, which is loose on the pin *M*, and carries the needle *O*. The driving pulley *C* is made very light, with two diameters for high and low speed engines, and is fastened to gear *E* by the feather *I* and nut *P*.

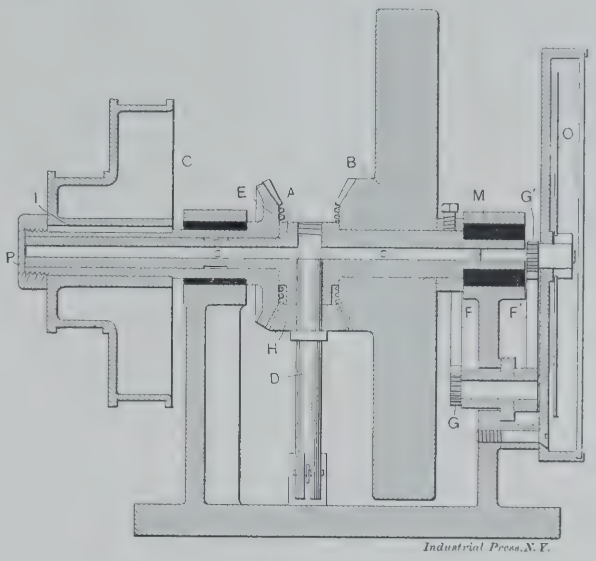

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Fig. 1.

The axis *D* is held in a vertical position by the two opposed torsion springs, Figs. 3. By using two springs under tension a large movement for a small increment is obtained, and the anglemeter may be run in either direction; and when running, a proper adjustment of the tension nuts brings the needle to a vertical position on the dial. A hair spring around the pinion *G′*, not shown in the cut, eliminates any lost motion in the multiplying gear. The anglemeter is driven by a belt from some part of the engine shaft, which through the intermediate bevel pinion and the tension springs, drives the flywheel in the opposite direction at a uniform velocity.

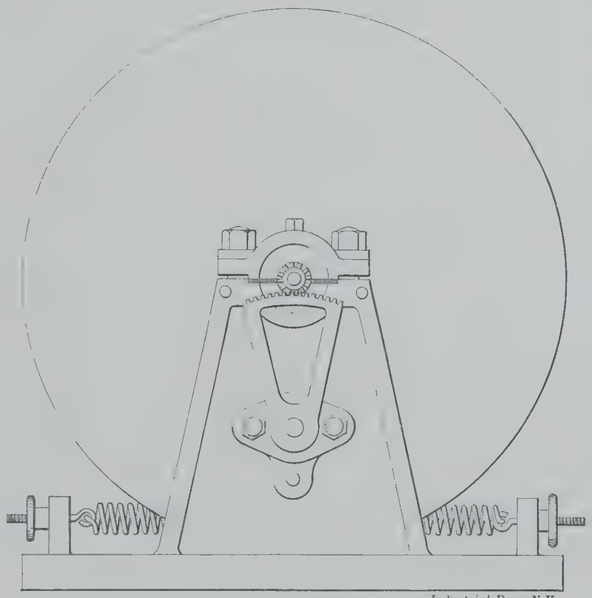
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Fig. 2.

If the tension of the springs which tend to hold the intermediate bevel-pinion axis in a vertical position is equal to the pull necessary to keep the flywheel rotating at a constant speed, then a change in the angular velocity of the driving pulley which varies with the change of the engine speed allows the axis of the bevel pinion to vary one-half the angle of driving pulley.

If the diameter of the pulley on engine shaft is such that the velocity of the anglemeter is 7.2 times faster than the engine, its angular variation during one rotation of the engine will be 7.2 times greater, and the angular variation of the axis of intermediate bevel pinion from a vertical or normal position will be 3.6 times greater than that of the engine; and the needle, which has an angular movement 100 times greater than the bevel-pinion shaft, will therefore have 360 times the angular movement of the engine flywheel from a uniform rotation. Therefore if the engine flywheel should vary one degree during a rotation, the needle on the dial would vary 360 degrees, or make a complete half revolution each side of the normal position. As the dial has 360 divisions or degrees, one minute variation of the engine shaft would show six degrees on the dial, and ten seconds variation of the engine would show one degree on the dial.

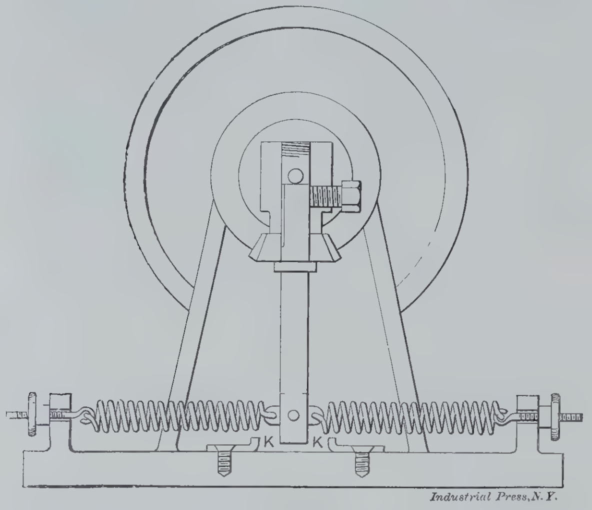

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Fig. 3.

A belted tachometer from the anglemeter flywheel shows a uniform speed under extreme angular variations of engine flywheel, which might be expected, however, when we consider that for a variation of one degree of engine the change in the length of springs is less than ¼ of an inch, and that for a variation of one minute the length of springs varies less than .004 of an inch. If, however, an engine is racing, the speed of the anglemeter flywheel will rise and fall in proportion to that of the engine, for it makes in a minute some multiple of the engine speed.

The belt which is used to drive the anglemeter is a piece of special cotton tape one inch wide, butt-jointed with an ordinary over-cast stitch, which makes it practically endless; and as there is no perceptible stretch and but little inclination to creep, the speed of the light driving pulley of the anglemeter should vary exactly with the engine speed.

The amount of deflection of the needle each side of normal is readily seen when the anglemeter is in operation. When applied to a gas engine working under normal conditions, having two impulses per revolution, as good results are obtained as from a single-crank steam engine, but if abnormal conditions arise, such as premature or missed ignitions, the trouble is at once located by the needle's usual deflections.

THE HOT WELL AS AN OIL EXTRACTOR.

Paper read by A. H. Eldredge at the Saratoga Meeting of the A. S. M. E., June, 1903.

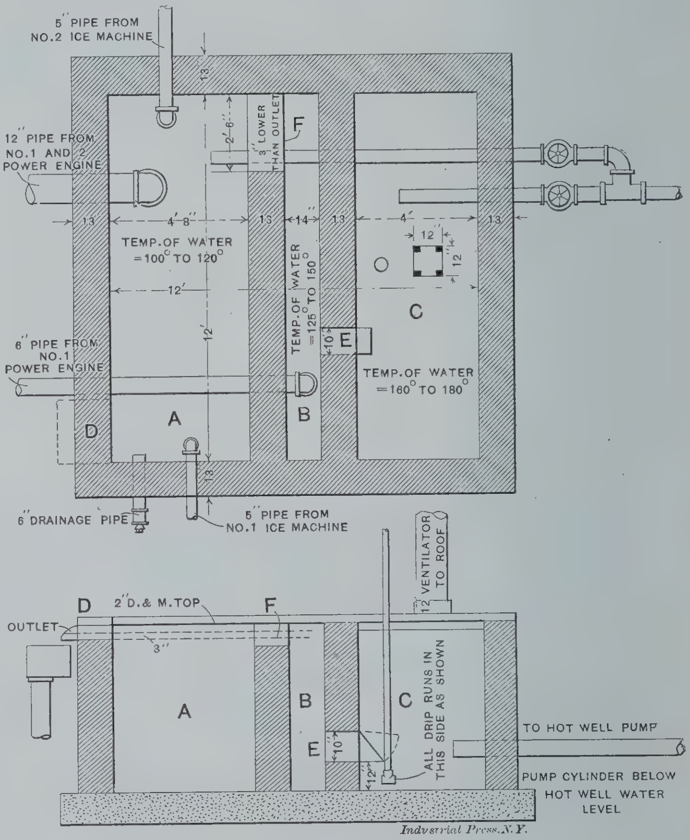
Figs 1 and 2 give the plan and cross-section of a hot-well that has been in successful operation during the past year. The well is divided into three parts:

A, the common discharge side for the steam condensers; *B*, the discharge side for one steam condenser; and *C*, the hot side, or pump side.

The operation of the well is as follows: The bulk of the condensing water enters at *A* and overflows, to a cistern, at *D*. The water from a single jet condenser enters *B*. The water from this condenser comes from an engine that runs continuously nearly the entire year. Its temperature is kept between 125 degrees and 160 degrees F. to favor the boiler feed temperatures, although at the expense of the vacuum, which runs from 20 inches to 24 inches. The higher temperature also saves condensing water.

There are two outlets from *B*, one an underflow at *E* into *C*, and one an overflow at *F* into *A*. The overflow at *F* is 3 inches lower than the one at *D* to insure a passage in and out of *B*.

The hot side, or pump suction side *C* is supplied from *B* through *E*. The temperature of this water is increased by returning to it, so far as possible, all steam drips, and pump, or other exhausts, raising its temperature to from 160 degrees to 180 degrees F. This gives a good start for a desirable feed water temperature, and at the same time saves many traps, together with their accompanying troubles and expense, insuring the return of the various drips with their British thermal units to the boilers. The only outlet from *C* is through the pump suction, and only such water enters *C* as is sufficient to supply the pump. Should the water at any time be cut off from *B*, then the supply would come automatically from *A* through *F*. The hot-well is provided with drain pipes in *A* and *C* for clean-out purposes.


5" PIPE FROM NO.2 ICE MACHINE
13"
2'-6"
3" LOWER THAN OUTLET
F
12" PIPE FROM NO.1 AND 2 POWER ENGINE
13"
4'-8"
13"
14"
13"
4'
13"
12"
12"
TEMP.OF WATER =100° TO 120°
12'
TEMP.OF WATER =125° TO 150°
C
12'
10"
E
6" PIPE FROM NO.1 POWER ENGINE
TEMP.OF WATER =160° TO 180°
D
A
B
13"
6" DRAINAGE PIPE
5" PIPE FROM NO.1 ICE MACHINE
12" VENTILATOR TO ROOF
D
2" D.& M.TOP
F
OUTLET
3"
A
B
C
E
10"
12"
ALL DRIP RUNS IN THIS SIDE AS SHOWN
TO HOT WELL PUMP
PUMP CYLINDER BELOW HOT WELL WATER LEVEL

Industrial Press, N.Y.

Figs. 1 and 2.

The water enters *B* at a comparatively high temperature, and any oil in the water will rise rapidly to the surface, while the oil from but one condenser is all that has to be taken care of. At the same time the flow of the water from *B* to *C* is very slow, giving ample time for the oil to rise to the surface and pass off through the overflow *F*.

Over 3,000 horse power of boilers, at one of Swift & Company's plant, are fed from this hot-well, and no sign of oil has been found in any of the boilers or their connections. The water from *C* has also been chemically analyzed a number of times, and but the slightest trace of oil has ever been found. The trace found was undoubtedly due to the oil coming in through a pump exhaust, and has in no way affected the practical working of the hot-well.

* * *

Elaborate tests have been made in England to determine the status of electric motors in coal mines, and the feasibility of employing them in dangerous mines in place of steam and compressed air motors. The tests show conclusively that the open type of direct-current, 500 volts, motor will cause explosions whenever immersed in a mixture of air and gas in the proportion of 9 of the former to 1 of the latter.

CUTTING TOOLS FOR PLANER AND LATHE.*

W. J. KAUP.

Planer tools will first come under our notice as being the simplest and requiring the least skill in setting. You have doubtless observed that if the chip be unwound from the spiral shape it assumes in leaving the tool, and projected in a straight line it is shorter than the surface from which it came. This is due mainly to the compression of the metal in the direction of the cut, and you will thus see the possibilities of saving power and strain upon the machine by giving proper cutting angles to the tools and reducing this compression to a minimum.

In Fig. 1 the cutting tool is at right angles to the work and without rake. It exerts its force in a direction nearly parallel to the surface of the work and having no side rake, either, it simply does not cut, but shoves or crowds the metal forward, producing a chip made up of little splints. It cannot exert any force tending to lift or curl the chip.

This tool is wholly wrong; nor would it materially improve it to grind like the tool shown in the little sketch at the right, which goes to the other extreme, and would spring into the work. A tool must first of all be heavy enough at the back or heel to resist the horizontal cutting force, and consequently should have very little clearance. The 7 degrees clearance shown in the lathe tool in the upper view, Fig. 2, is too much for a planer tool, while the 3 degrees of the lower sketch is as small as can be used safely. Theoretically if the point leads by only a thousandth or two it will perform its function. There should be very little top rake on account of its tendency to make the tool dig into the cut; but this can be compensated for by giving considerable side rake.

Another reason why a planer tool tends to dig into the work is illustrated in Fig. 3. Point *A* in each sketch is the fulcrum. In the first sketch the tendency is for the tool to dig into the work in the direction of the arrow. This is not so serious as appears on the face of it, as planer tools are usually so stiff that they will spring but little and any error that might occur in the roughing cut would be eliminated in the finishing cut. What many mechanics take as an indication of the spring of the tool is really due to the chatter of the planer; since a rack and pinion planer will frequently chatter after it has become worn, while in a worm-driven planer the lost motion is all taken up at one end before beginning the cut and the screw action does away with the chatter. To obviate any spring the tool may be designed as in the second sketch, Fig. 3, where the deflection due to the force of cut is away from the work in the direction of the arrow.

The tool in Fig. 4 approaches the ideal for a finishing tool, and gives the best finished surface of any that I have used on planer or shaper. It is made from a piece of ordinary tool steel and forged on the end in the shape indicated. It will be noticed that it has side rake and instead of being straight on the bottom, the line that comes in contact with the work is a little rounding.

We will now take up the subject of the cutting edges of some of the many varieties of lathe tools, Fig. 5. Here are shown a diamond point, a round-nose tool, a side tool, centering tool, thread-cutting tool, and cutting-off tool. We will first consider the diamond point as it is more of a universal tool than any of the others. Before speaking of rake, clearance or the setting of the tool I want to call attention to the general form of the cutting edges and the importance of maintaining the same throughout the life of the tool.

Fig. 7 will best illustrate my meaning. The tool is shown at the left with depth of cut, and ground so that angle *x* shall not be less than 55 degrees. To the right is a tool in which the angle has been changed by grinding on both sides of the point, only, because the machinist claims that he is in a hurry and must make time on his work. But it will be seen that the line of cut *b* is much greater than the line of resistance *a*, showing loss in efficiency in the tool and requiring more power to drive it after it had been ground. Nor is this the only reason why careless grinding will produce a loss, as I will proceed to prove.

This is true with proper rake, angles and clearances, but when the mechanic ignores all principles and is careless, besides, how much more serious it becomes, because more finishing cuts will be required to make the piece straight. The nearer the cutting edge of the tool comes to being parallel with the axis of the work the more power will be required to operate the tool.

It will be interesting to note what really takes place in turning, as shown in diagrammatic form in Fig. 8. Here is represented a piece of rough stock that is to be turned as indicated at the right. First, starting at the corner line *A*, and developing the line of circumference in a straight path, we will get a line like (1). After turning and repeating the process, the developed line will look like the line at (2). It will be noted that the second line is somewhat irregular, showing that even after roughing off, the surface of the piece has nearly all the irregularities of the rough stock, though on a smaller scale.

This brings us to another important point, and that is the necessity of centering work as accurately as possible, for no matter how even the work may be on its circumference, if centered out of true, it will not be round after turning. Why? Because the thickness of the chip or shaving is not uniform, hence does not offer uniform resistance to the cutting edge and the work will bend more at one point than the other. If the cut were uniform and offered the same resistance, of course we could expect round work.

The bottom figure on the sketch illustrates the tool and method of obtaining the lines. A long, light lever has a knife edge or point at one end, near the fulcrum, which bears against the periphery of the work. On the other end is a lead pencil attachment, the point bearing against the piece of paper indicated, the paper traveling at the same rate of speed as the work, only in the direction of the axis of the work. Any unevenness in the surface of the work raises or lowers the point of the pencil and as the ratio is great (20 to 1), the variation in the line is marked.

Referring to Fig. 2, we will take up the rake and clearance of lathe diamond point tools. The angle or clearance, sometimes called the angle of relief, as indicated here, is about 7 degrees, and sometimes runs to 10 degrees, more or less—enough for a safe working angle. Really the only reason for so much clearance is to avoid rubbing against the cut surface, thereby causing unnecessary frictional resistance to the motion of the lathe. Our efforts should be directed toward finding the angle that will give the least force required for cutting, combined with endurance of tool edge.

While the power required to cut is increased greatly by dullness of the cutting edge, we must avoid the wood chisel edge because time lost in constantly removing the tool for grinding purposes eats up the profit. In Fig. 9 are illustrated two extreme cases—that on the left, too great top rake and the other without any. The one will do good work for a few minutes, provided the cut is not too heavy, but the wear of the edge is so great that the angle would soon become blunt and it would be very much better to have no top rake at all. On the other hand, the cutting wedge, as I will call the tool ends on the right, is too blunt to do good, clean work, and from the position in which it is set, the chip will come off nearly straight and in small pieces. The happy medium between the two is indicated in Fig. 10.

Side rake means the angle at which the top is ground either to the right or left side. A tool ground for a traversing motion toward the left-hand, cannot be used with a motion toward the right. Therefore side rake is designated right-hand or left-hand, the former being that which has its cutting edge on the right side and the latter on the left side. As the side rake is increased, the power to drive it on in its traversing direction becomes less as it tends to screw its way along.

Fig. 11 illustrates an important point in setting the tool. The further the cutting edge is from the base, or support, the greater will be the spring. Where this spring is possible the point is drawn down into the work as indicated by the dotted line, and furthermore will produce irregularly-shaped work due to the variation in the resistance of cut at points where the tool digs in. This indicates the value of short leverage.

In Continental shops, and especially in England, it has be-

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* During the last school year the author gave a series of lectures at Pratt's Institute, Brooklyn, before his evening classes in machine work. The accompanying article is an abstract of the lecture on cutting tools.—EDITOR.

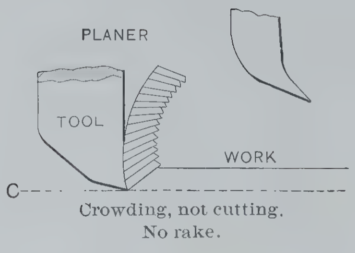


Fig. 1

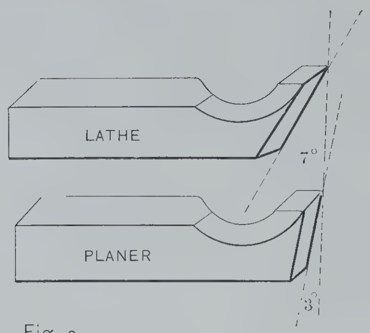


Fig. 2

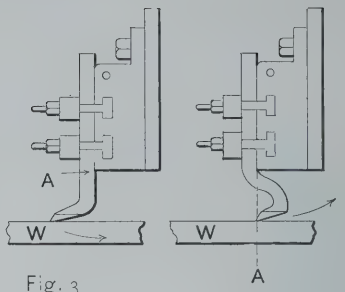


Fig. 3

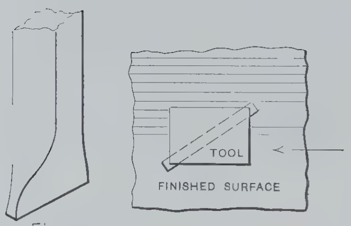


Fig. 4

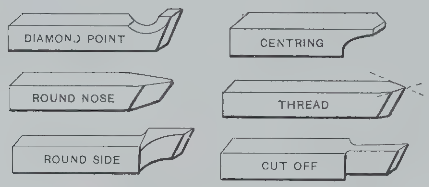


Fig. 5

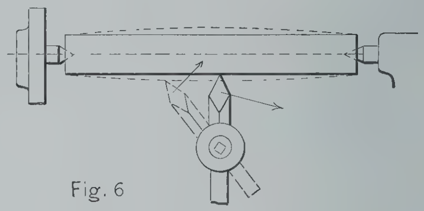


Fig. 6

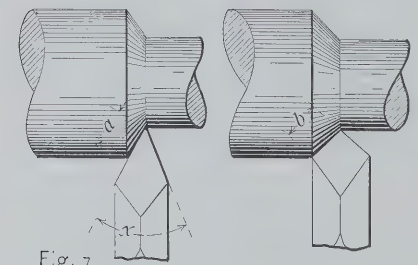


Fig. 7

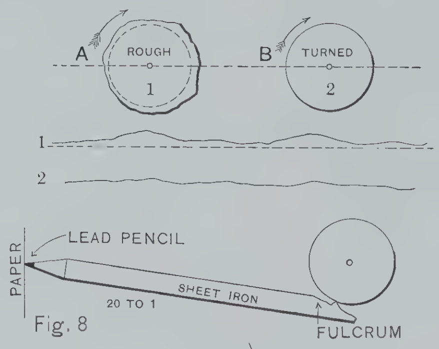


Fig. 8

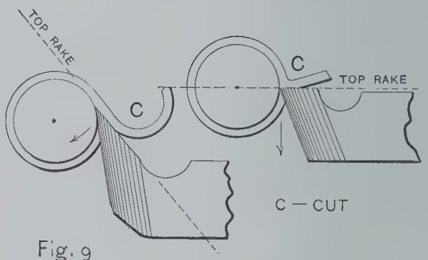


Fig. 9

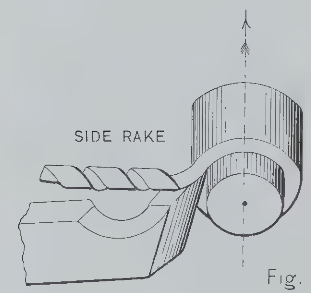


Fig. 10

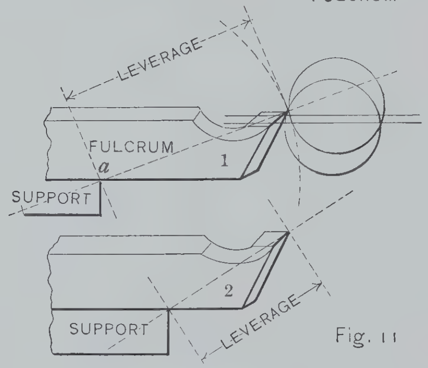


Fig. 11

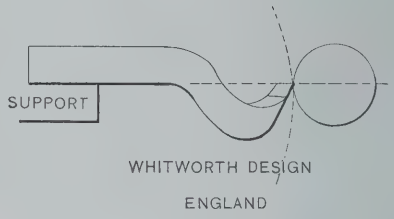


Fig. 12

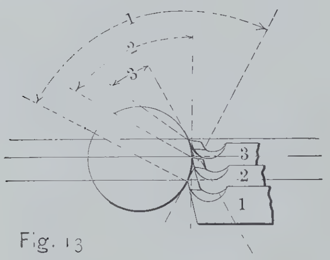


Fig. 13

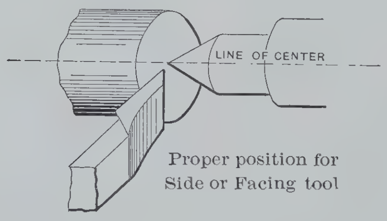


Fig 14

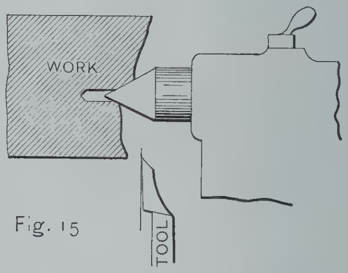


Fig. 15

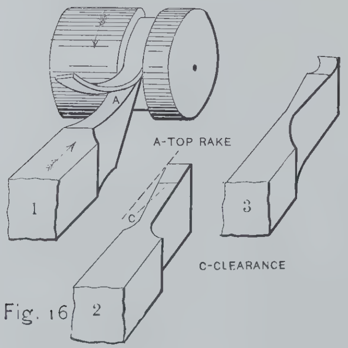


Fig. 16

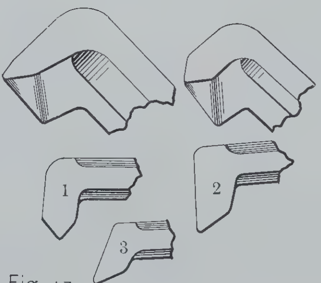


Fig. 17

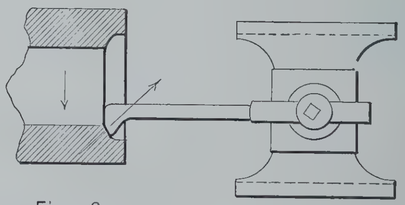


Fig. 18

Industrial Press, N.Y.

Reproduction of Lantern Slides Accompanying Lecture by W. J. Kaup.

come a recognized principle that the top of cutting edge of tool should not be higher than the top of the support and to obtain its top rake the tool is hollowed out by grinding. Sir Joseph Whitworth designed his lathes so that the tool set on the center of the work and any vertical pressure deflected the tool away from the work, as shown in Fig. 12.

Next in importance to the leverage of the tool is the angle at which it is set in relation to the work. Referring now to Fig. 6, the tool is shown at right angles to the work and the cutting pressure tends to force the tool around to the right, away from the work, in the direction of the arrow, instead of causing it to dig into the work. If the tool were set as shown in the dotted position it will readily be seen that any slipping or deflection would carry it into the cut.

The third point to be observed in regard to setting the tool is its height relative to the lathe centers. Fig. 13 illustrates this. Tool No. 1 is set below the center and the dotted line, drawn tangent to the point of the tool on the periphery of the circle, indicates the direction in which the cutting force is applied. The top or cutting surface of the tool forms an angle of 90 degrees with this line. The stock is thus merely crowded off by the tool and there is no cutting or wedge action whatever. The next tool is set on the center and has more of a wedge action, but still not what it should have. The top tool, No. 3, gives us the best cutting wedge and will do maximum work with minimum resistance.

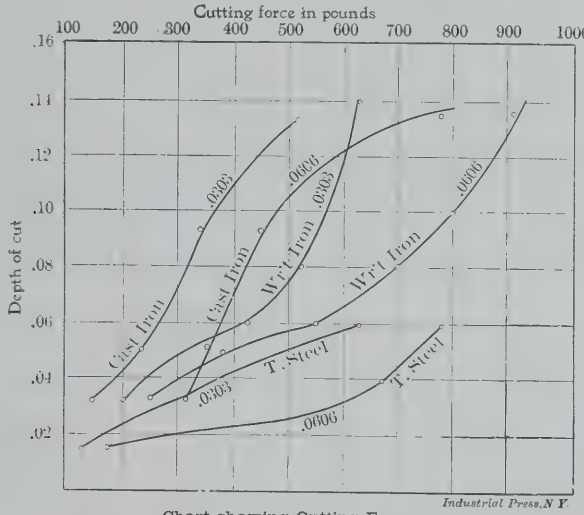


Chart showing Cutting Force.

From the foregoing it is clear that the lathe tool will do the best work with combination of top and side rake, when caught very short, at right angles to the work, and when set above the center. This will lead to economy.

Now a point about grinding: The diamond point tool should be ground only on the top, and the angles on the sides should never be touched, and there will be no danger then that you will destroy the economic value of the tool. Many mechanics burn the cutting edges of the tool in grinding, by simple carelessness, which makes the edge softer than the metal it is supposed to cut. My references thus far have been confined entirely to the solid tools, most commonly used. But there are many improved tool holders in use, designed for self-hardening steel which is not affected by burning in the hands of incompetent mechanics, either in grinding or through lack of knowledge of the proper cutting speeds. These holders support the steel in such a position as to give the proper front and side clearance and the rake is determined by the grinding.

Following is a table of finishing speeds and feeds for different metals for tools of ordinary tool steel. In roughing the axiom is slow speed and quick feed; finishing high speed and fine feed. From this table I should deduct 25 per cent. for roughing speed, making 18, 24, 28 and 83. Experiments on cutting tools made in the shops of R. H. Smith, London, England, and verified by the author, show that machine steel requires from two to two and one-half times the power for cutting, as does cast-iron, and wrought-iron about one and one-half times the power. The results are given in detail in the chart herewith and show that an increased force is required for increased cutting speed.

LATHE AND PLANER CUTTING SPEEDS AND FEEDS.

Tool Steel.		Wrought Iron Machine Steel.		Cast Iron.		Brass.	
S	F	S	F	S	F	S	F
24	25	32	25	38	22	110	20
Lub.		Lub.		Dry.		Dry.	

F = Number of revolutions to 1 inch feed.
S = " " feet per minute.

The round nose tool, Fig. 5, is used for brass, when made rather pointed and for facing cast iron when it has a blunt point. The tendency with brass, which is very soft, would be to pull a hooked tool into the work. The side tool should always be set with the point leading slightly, but remembering that it is not the point but the side of the tool that is to do the cutting. This tool should be set on the center, as indicated in Fig. 14. Fig. 15 shows the necessity for facing up work with the side tool before turning; otherwise the center will give more support to one side of the work than the other and the pressure of the tool used later for turning will be likely to produce a crushing of the metal at the center, on the side of the least support.

The centering tool should be ground like a twist drill and placed with its cutting point directly at the center of the work and used to obtain an accurate center for starting a drill. Much carelessness is exhibited in the use of the thread cutting tool, not so much in grinding as in setting. It should be set so that the cutting edges are directly on the line of lathe centers and, of course, at right angles to it. The economical way to use this tool is to rough out the thread with a heavy cut and then regrind the top face until again sharp and then finish with a light cut. No matter how carefully a thread tool is used, the sharp point will wear rapidly.

Referring to Fig. 16, we come to the cutting-off tool, the last of the lathe tools shown in Fig. 5. The upper view shows the action of the tool and the two lower views indicate how good and poor results may be obtained through grinding. This tool has side clearance, right and left, and should be ground slightly concave on its top face. Its point should be on a level with the center of the work.

In Fig. 17 are indicated several of the commoner types of boring tools. The vertical pressure on boring tools is very nearly constant (Fig. 18), and when the tool starts to cut, the depression or spring downward remains very nearly constant throughout its entire cut, and so does not vitally affect accuracy. The tool wears as it advances, however, and this tends to produce a conical hole. Lathes are adjusted, also, so that in no case will they bore a hole larger at the back than at the front, and in making this adjustment the tendency is to have the lathe so it will bore very slightly smaller at the back—another reason why bored holes are frequently a little tapering.

* * *

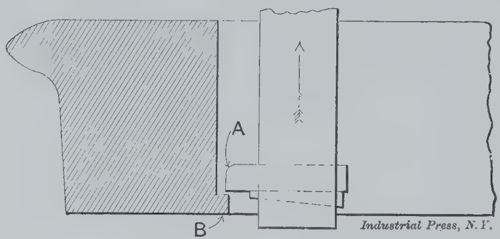
If the development of high-speed tool steel makes as much difference in the power required to drive machine tools during the next few years as it has since the advent of the Taylor-White process, we may soon look for the power plant of a moderate-sized machine shop to rival in extent that of a fair-sized central power station. When locomotive frame planers come to have electric motors of 80 H. P. and other tools in proportion, it is not too much to say that the future machine shop will require hundreds of horse power where tens sufficed a few years ago. As an illustration of the enormous motor equipment being applied to some minor tools we may mention that of an axle lathe recently built by Bement, Miles & Co. for the Howard Axle Works, Homestead, Pa. This machine is of the central-driven double-head type having four cutting tools. The driving gear in the center through which the axle passes, has an opening 12 inches in diameter, and the distance between the extreme centers, is 8 feet 4 inches. It is very solidly constructed and is, of course, a heavy tool for its class, but who would have anticipated the application of a 60 H. P. motor to drive it? Such is the case, however, a 60-H. P. motor being belted to a countershaft having 42-inch pulleys with 10-inch face and running at 360 revolutions per minute!

LETTERS UPON PRACTICAL SUBJECTS.

A TRICK IN BORING TIRES.

Editor MACHINERY:

Some time ago I was in a railway shop where rapid work is being done on a boring mill—boring locomotive tires. A well-known brand of high-speed steel was used for the boring cutter, and the cuts were run through with a heavy feed and at three or four times the speed that would be possible with ordinary tool steel. Each tire was bored at two cuts, but near the end of the finishing cut it was necessary to change the cutter having a rounded lip for one having a square lip so as to square up a shoulder *B* shown in the accompanying cut. This shoulder or lip bears against the wheel center and acts as a sort of retaining ring to prevent the tire slipping inward when the locomotive is rounding a curve, etc. When using the square edged cutter it is necessary to run at a somewhat lower speed and this materially increases the time required for finishing each tire, although the total time required is only a little more than an hour for a 68-inch tire.



Boring Locomotive Tires.

It seems to me that the change of cutter necessary when feeding downward could be avoided in this case by the simple expedient of feeding upward. The cutter being ground with a square corner on the lower side and rounded on the upper side at *A*, would be well suited for finishing the job without change. Starting the cut at the shoulder, the cutter would be fed into the cut by the cross feed until the required depth was attained. Then the longitudinal feed should be thrown in and the tire bored at the maximum rate without any "nursing" whatever.

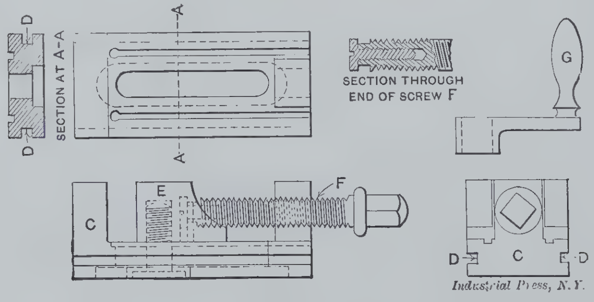
F. EMERSON.

Newark, N. J.

A HANDY TOOLMAKERS' VISE.

Editor MACHINERY:

We all know how difficult it is at times to handle small pieces of work accurately, it often being necessary to solder them onto a plate in order to do any kind of work upon them. Any one having much of this kind of work to perform will therefore appreciate such a vise as is shown in the accompanying sketch and which I have made for holding small pieces to be operated upon. It is not like the regular vises which may be purchased, in that it may fairly be classed as an accurate tool. It is not only made for use on the drill press but may be used on any side or end as the work makes most convenient, since it is made perfectly square and parallel on all sides. The sketch is just half size and requires but little explanation.



Toolmakers' Vise.

C is the body, made of machinery steel and case-hardened. The slots *D D*, along the sides, are used for clamping the vise down or for swinging it upon a faceplate. The movable jaw *E* is likewise made of machinery steel and case-hardened. The screw *F* is 5-16 inch in diameter, cut with 20 threads per inch, and has a No. 8-40 screw in the end, the head of which works in a T-slot in the movable jaw, thus forcing it forward or drawing it back. Both screws are spring tempered and lapped to a perfect fit. The end of the larger screw is squared off and to it is nicely fitted the wrench *G*. All parts are lapped accurately so that drilling holes, or milling and planing faces, at right angles with each other can be accurately accomplished by its use. I have found it one of my handiest accurate tools but it must be very carefully and accurately made, otherwise it will be no better than any of the vises that may be purchased.

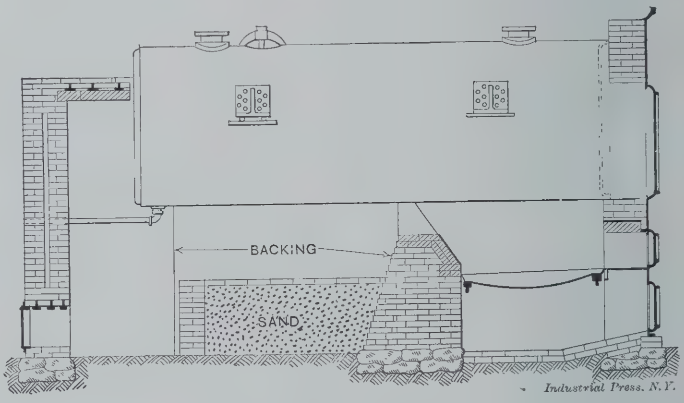
J. M. S.

REGARDING BOILER SETTINGS.

Editor MACHINERY:

Regarding the sketch of a boiler setting, shown by Mr. Perrigo in the May number of MACHINERY, there is one point that is of considerable importance in the economical working of the boiler which has not been mentioned. This is the building up back of the bridge wall so as to form a prolonged combustion chamber in which the gases may be more thoroughly burned than would be the case if the bridge wall was not backed up; for it is a well-known fact that combustion is not completed in the furnace but continues after the gases pass over the bridge wall on their way to the stack. This fact was forcibly called to mind by two cases which recently came to the writer's attention in connection with power plants.

A new plant had been supplied with a battery of boilers, two to be used constantly while the third was to be held in reserve. After running for some time with two boilers it was found necessary, on account of extra work, to place the third in commission, but even with the most careful handling and well-managed firing it was impossible to make the third boiler steam as efficiently as the other two. After running for a while, however, its steaming capacity came up to that of the others. The reason of this action was the filling up, to some extent, of the space back of the bridge wall with ashes and thus forming a better combustion chamber. While the steaming was improved by the ash filling, it was not what it would have been with a properly designed combustion chamber.



A Backing for the Boiler Setting.

Another case in point, which illustrated more clearly the economic value of building back, was that of a set of boilers which were supplied with the ordinary bridges. After a time the consulting engineer became dissatisfied with the running of these boilers, and backings were built behind the bridge walls. These boilers were run night and day and by putting in the backings a saving of five hundred pounds of coal was effected in twenty-four hours.

This matter appears to be of so great importance that it should not be neglected in the design of a boiler setting. The accompanying sketch shows the boiler setting referred to in Mr. Perrigo's article, to which has been added a brick and sand backing which would, I am sure, add considerably to the efficiency of the boiler.

J. A. P.

PUNCHES AND DIES FOR DRAWING AN ODD SHAPED BRASS CUP.

Editor MACHINERY:

The set of punches and dies here described, while not exceptionally out of the ordinary, may have one or two points that will be of interest to any one engaged in this class of work, and my experience in producing the punch by which the final operation was performed may prove of assistance to some one having a similar punch to make. The sketches, Figs. 1 to 4, show the progressive operations from start to finish by which the piece shown in Fig. 4 was produced. This is a corrugated, conical cup, drawn from a round blank of soft brass 3-32 inch thick and 2 5-16 inches in diameter. The corrugations project externally, and internally form six equally spaced, square grooves which converge radially and disappear within about 3-16 inch of the bottom. The specifications in this case required that there should be developed on the outside a distinct shoulder at the base of the conical part and that this shoulder be formed on the corrugations only. On the inside no shoulder should be visible but the formed grooves be made to disappear uninterruptedly near the bottom. It will be seen that the pressure in the last drawing had to be much greater than ordinary in order to accomplish these results, for the stock at the point where the straight and conical portions met was pressed out quite thin in order to develop the shoulder.

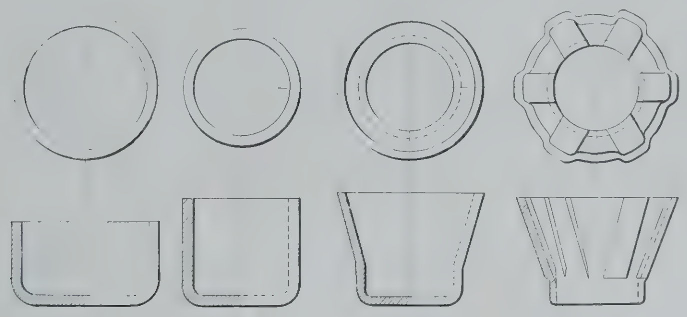


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Industrial Press, N.Y.

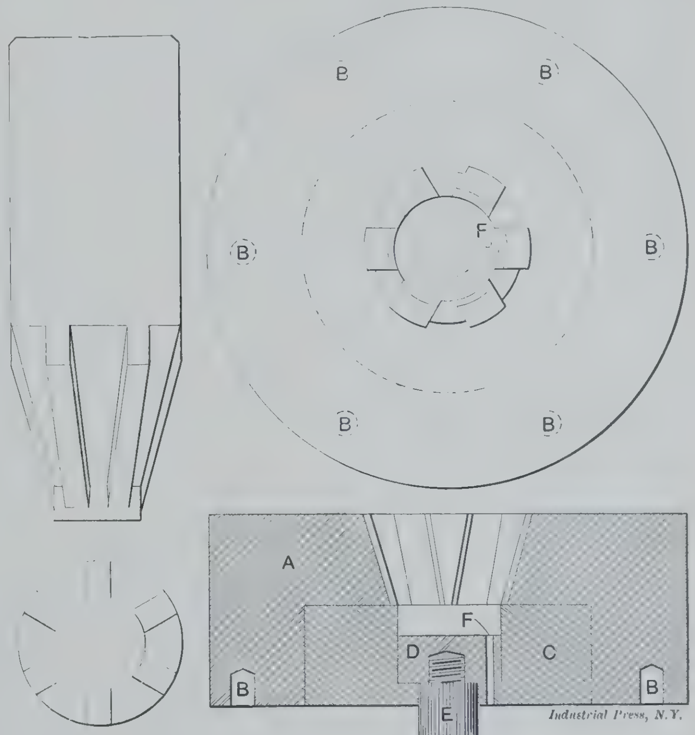
The Successive Operations for Drawing Brass Cup.

The dies and the shanks of all of the punches used were made of a uniform size so that two holders, one for the punches and one for the dies, were all that were required. The punches were secured by a setscrew and the dies were seated in the holder and held fast by four setscrews, equally spaced around the side, with their points set into the circumference of the dies. To make the change from one operation to the other it was only necessary to loosen the screws, remove the tools in use, and substitute the ones next in the set. Each drawing operation was followed by a careful annealing in order to insure the equal flow of the metal and to minimize any possibility of cracking.

The main problem was to make the finishing punch as cheaply as possible and have it stand up under the severe work required of it. It was first made in sections by turning it to shape and then dovetailing to receive the elevated pieces which were made separately and forced into the dovetails up against a shoulder. Then the end was drilled and tapped and the straight tip screwed on. The parts having been carefully fitted were marked, removed and hardened, and then replaced as before. The punch made in this way had been used for a short time when the elevated pieces began to chip and crack, where the strain was the greatest, and often one hundred or more cups would be run through before the defect was noticed. For this reason the hardened sections were replaced by soft ones, but after a short run they would flatten down and make continual repairing necessary. To overcome the trouble the punch was finally made as shown in Fig. 5, from a solid piece of tool steel. This was milled, chipped, and filed to a finish and after hardening was drawn to a light straw color. After this no more trouble was experienced.

The first and second drawing dies were made from tool steel disks, 5 inches in diameter and 2 inches thick, with holes to draw the cups as shown in Figs. 1 and 2. These dies were of the plain push-through type with a sharp edge on the under side to strip the work from the punch which was made slightly tapering and of a diameter equal to the inside of the cup. In this case the punch was made two thicknesses of the stock plus .008 inch, less than the hole in the die. Previous to the last operation it is general to make the punches more than twice the thickness of the stock smaller than the die and to taper them ⅛ inch per foot to assist in stripping the work, for in most cases the exact sizing of drawn work is of little importance up to the last operation. Consequently tapering the punch and making it below size will in no way interfere with the finishing of the work which is all done in the last operation by a punch and die that must be made of suitable dimensions to meet the requirements. The rule usually adopted is to make the punch small and tapering for short cups of thick metal and nearer to size for thin stock, for the latter is more apt to develop body wrinkles if not properly pressed out in the die. The die for the third operation is made the size of the finishing die but with plain walls.

The die for producing the finished work is shown in Fig. 6. The part *A* was first turned and bored in the lathe and then fastened on a special arbor fitted to the spindle of the dividing head of a milling machine. Six ¼-inch holes were drilled and reamed, as at *B B*, the piece being indexed so that they would be accurately spaced. A special angle iron was made for holding this piece at the angle of the sides of the die, and two holes were carefully drilled in its face to correspond with a diametrically opposite pair of the drilled holes in the back of the die. In these holes were driven ¼-inch guide pins which projected 3-16 inch above the face of the angle iron. The angle iron was then bolted to the knee of a shaper and the die located on its face, by the pins, and strapped firm and true. The six drilled holes provided a means for accurately locating the die for planing the grooves, which was done with a formed tool screwed on the end of an extension shaper tool of the kind usually used for internal work. After shaping, the grooves were filed and polished dead smooth and the die was hardened. The piece *C* was turned and ground to a light driving fit in the back of the die and both pieces surfaced on the under side. *D* is a steel pad and *E* a stud for stripping the finished work. They are operated by the press ram on its upward stroke. The vent *F* is for the escape of air. Following the drawing of the cup the bottom was punched out in a plain cutting die. C. H. ROWE.



Industrial Press, N.Y.

Figs. 5 and 6. Punch and Die for the last Operation.

Salem, Mass.

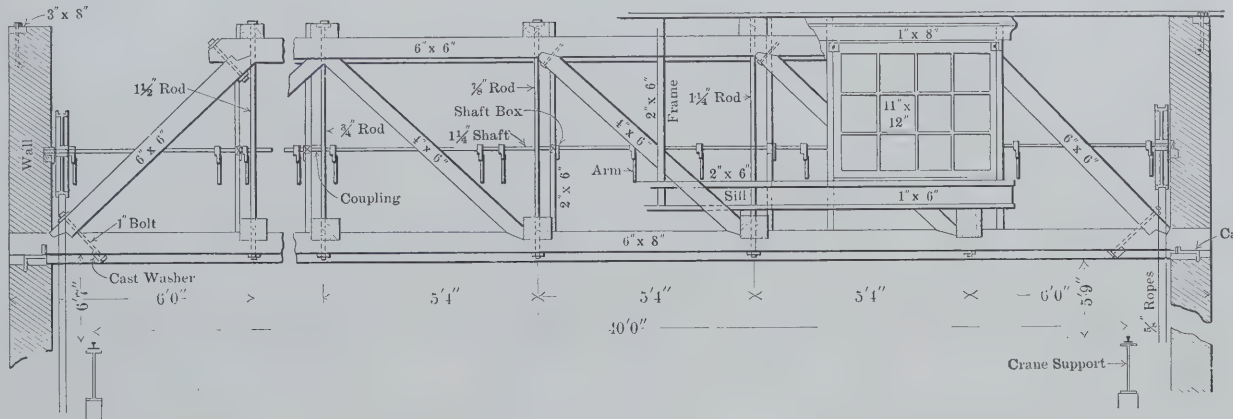


Fig. 1. Truss of Saw Tooth Roof.

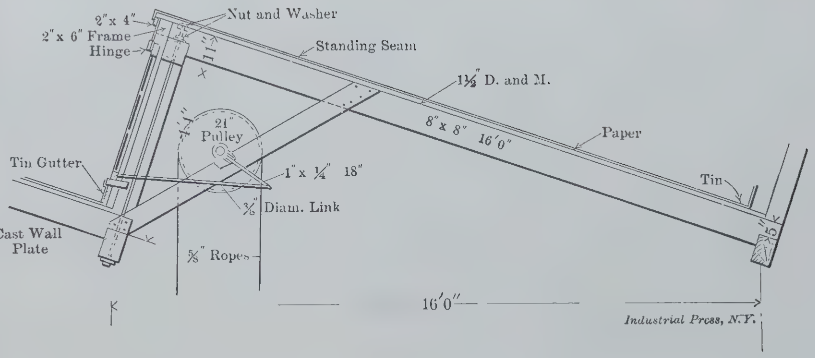


Fig. 2. Section through Wooden Saw Tooth Roof.

WOODEN SAW TOOTH ROOF.

Editor MACHINERY:

Never having seen the description of a saw tooth roof of wooden construction, and but few of steel, I think the following description may be of interest in connection with the articles on shop construction, recently published in MACHINERY. That the saw tooth roof possesses many advantages is attested by the number of cases in which it is employed in the construction of the most up-to-date shops. Most of these are steel buildings but it is perfectly practical to use this style of roof for wooden buildings as well. The cuts illustrate a wooden roof of this construction and incidentally show a truss over a craneway and also a window-operating device that is comparatively inexpensive.

The truss and roof details are quite clearly shown but a few points may be noted in explanation. The side walls have buttresses on the outside to keep the craneway in line but in addition to these it is considered desirable to have the trusses assist in keeping the track in place. With this end in view, cast iron wall plates, of the type shown, are employed. These plates have a projecting flange extending down into the wall about 3½ inches and on the upper face is a rib, 1 inch high, placed at an angle. The timber is mortised out somewhat wider than the space occupied by the rib, and when the truss has been placed on the wall plate, hard-wood keys are driven in on either side thus keying the lower chord in position in an easy and economical manner.

As may be seen in Fig. 2, the truss tie rods have a long thread on the upper end which is for the purpose of convenience in erection. The truss is framed and brought up to tension on the ground, then raised in position and the rafters placed on top, after which the second nut and washer are put on the end of the rod and drawn up. The rafter is countersunk for the first washer and nut and for as much of the second one as will not be taken care of by the thickness of the roof. In order that the countersink be as shallow as possible, the washers are made of ⅜ inch steel, being cut from ⅜ x 3-inch steel plate. The lower end of the rafter is slotted to allow it to be placed on the tie rod at the bottom chord and after it is in place a piece is fitted into this slot, more for appearance than for any real use. The rafters are shouldered down at both ends to take the thrust due to the inclined position of the truss and roof. The trusses are placed at an angle for two reasons: First, because the theoretical distribution of the light is better, and second, because there will be less waste of lumber as the rafters can be made from 16-foot sticks.

To provide for the proper drainage, the entire roof is placed 10 inches higher on one side than on the other, as shown by the clearance from the crane rails. This gives a slope of about ¼ inch per foot and has proved very satisfactory. The roofing is standing seam steel laid on tarred paper, the paper being coated with hot roofing pitch before the roofing is applied. The gutter is made of tin flashed up onto the window sills. The window frames were made by spiking 2 x 6-inch stock onto the face of the trusses and cutting in the window sills, the sash being flush with the edge of the 2 x 6-inch pieces. Stops are placed on the sills and can be placed on the sides also, if thought best, although we have had no trouble by the rain beating in at this point. The hinges are made from 1¼ x 1¼-inch angles, holes being punched in one end for wood screws and in the other for ½-inch machine bolts. The angles were fastened to the 2 x 6-inch pieces and to the sashes, the machine bolt forming the fulcrum. The hinges are, of course, placed as high as possible and the windows are operated by the mechanism shown in the drawing. One-half of the windows in each tooth are operated by each set of mechanism. A ⅝-inch rope is wound around a 24-inch pulley mounted on the end of the operating shaft, the ropes passing down outside of the crane rail. The shaft is 1¼-inch rough stock and the bearings, arms, etc., are cored 3-32-inch large and attached by setscrews. The two lengths of shaft for each tooth are placed in line, a coupling being fastened to the end of one and the end of the other being a loose fit in this coupling. The supports are cast to rest upon 2 x 6-inch braces which also serve to strengthen the roof to which they are fastened with wood screws. The arms are fastened to the operating shaft by means of setscrews passing through their hubs.

The link which connects the arms with the sashes are of ⅜-inch rough rod, one end of which is given a short turn and passed through the arm and held in place by a cotter pin. The other end passes through a screw eye fastened to the lower part of the sash and is likewise held in place by a cotter. As shown on the drawing, the arms have to be set so as to allow the links to clear the diagonals of the truss; in fact this seems to be the only real objection to having the diagonals come in front of the windows, and this in no way affects their operation. This saw tooth roof is the second that has been built from this design and it has proved entirely satisfactory.

C. J. MITCHELL.

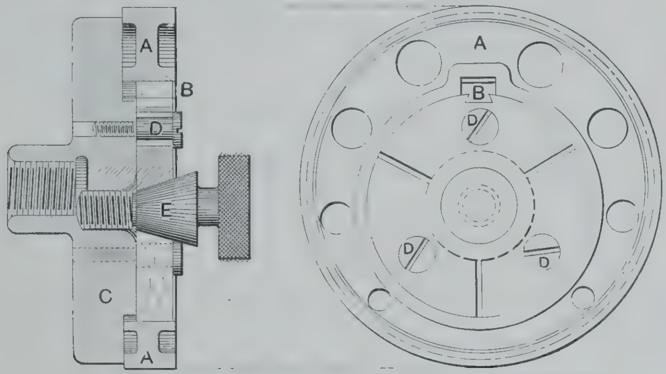
Beloit, Wis.

MACHINING AN ECCENTRIC RING.

Editor MACHINERY:

In a jobbing shop in which I was employed an order was secured for a large number of eccentric brass rings of the shape and section shown at *A* in the accompanying figure. They were to be bored out, faced on both sides and turned on the periphery, all dimensions being made to gage so that the pieces would be interchangeable. In order to turn out the work at a profit it was necessary to design and build a few fixtures for the rapid handling of the pieces. Two chucks were made for this purpose. The first, which held the ring while the eccentric hole was bored and one side faced, was of no especial interest so it is not described. After this operation the keyway at *B* was machined with the aid of a simple slotting fixture.

The chuck that was employed for the last operation, that of turning the periphery and facing the remaining side, possessed several features of general interest that might be adapted to other work of a similar nature. This chuck is shown in the cut, holding one of the rings in position to be operated upon. The body of the chuck, *C*, was threaded to screw onto the spindle of the lathe and carried on its face three expanding and contracting segments for holding and truing the ring, one of them being provided with a key which fitted the keyway *B* for locating and driving the ring. These segments were held to the faceplate by three shoulder screws *D*, *D*, *D*, which passed through radial slots, thereby allowing the segments an in-and-out movement across the face of the chuck. This expanding movement was imparted to the segments by means of the knurled head expanding screw *E* which was tapered to fit the tapered hole in the inside of the segments. The outside of the segments was tapered slightly so that the tendency, when they were tightened or expanded, would be to force the work against the faceplate. The clamping surfaces were eased off so that only about one inch of each would bind against the work.



Industrial Press, N.Y.

Chuck for Turning Eccentric Rings.

The manner in which the chuck was used and the work machined was as follows: The stud *E* being screwed outward by grasping its knurled head, the segments were contracted. Then the ring was located against the faceplate with the key in the segment fitting the keyway *B*. The expanding stud was screwed in and the segments in expanding forced the work against the faceplate and held it securely. It was then a simple matter to turn the periphery to the required diameter and face the side, after which the segments were contracted, by unscrewing the expander, the finished piece was removed and another one located ready for machining. As will be understood, the machining of the rings with the usual means handy around a jobbing shop would have been difficult and would have consumed much time; while by this method there was no time lost and the complete interchangeability of the rings when finished was guaranteed. It was surprising how easily and rapidly the rings were located and removed and how tightly they were held. As the brass castings from which the rings were finished were not of the best quality, and were sandy and scaly, a cut of considerable depth had to be taken, thus putting considerable strain on the segments. LATHESMAN.

SOME CONVENIENT LAPS FOR SHOP USE.

Editor MACHINERY:

The accompanying sketches illustrate some laps that were used in the grinding department of a shop with which the writer was recently connected. The lap shown in Fig. 1 was a plate of cast iron which was first scraped to a smooth surface, after which parallel grooves, 1-16 inch wide by 1-32 inch deep were cut upon the surface, forming small divisions ⅜ inch square. This plate was charged with fine emery and turpentine and when used on keyseat gages, or other flat pieces, was capable of producing a very fine surface.

Fig. 2 shows a lap formed of a smooth turned piece of hard wood onto each end of which was fitted a ferrule of wrought iron to prevent splitting. A narrow slot was sawed through the center and into this was driven a wooden wedge to compensate for wear. One of these laps would last for a long time and they were used on milling cutters when the amount of stock to be removed from the holes was not sufficient to warrant the use of the grinder. The lap shown in Fig. 3 was a cast iron cylinder that was bored to fit the arbor with which it was to be used. Three strips of lead were dovetailed across the surface and these carried the charge of emery and turpentine or oil. Three small tapered holes were drilled and reamed longitudinally and tapped at the small end to receive the taper expanding screws. After these were fitted, diagonal slots, which intersected the holes, were cut, so that by a slight turn of the taper screws the lap could be expanded to adjust it for wear. This lap was used on the inside of ring gages.

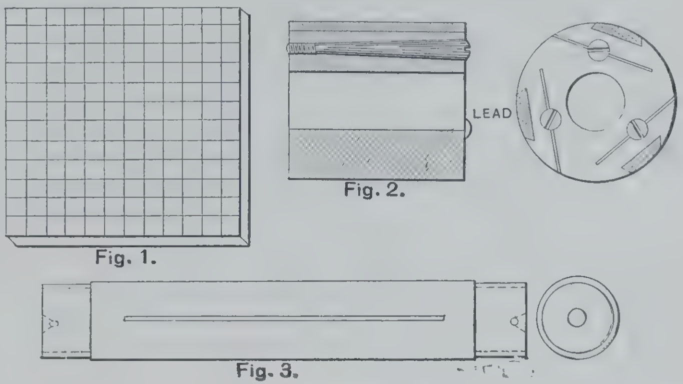


Fig. 1.

Fig. 2.

Fig. 3.

Flat and Internal Laps.

For lapping the outside of plug gages we used the lap shown in Fig. 4, which consisted of a casting bored out to the required size and fitted with three wide strips of lead. A slot was cut through the lug on the upper side, and this was fitted with a pair of setscrews to form the means of adjustment. A handle was provided to prevent the lap from turning while the plug gage upon which it was being used was revolved in the machine.

Under the subject of lapping might be mentioned a little job that appeared to the writer to be rather novel. A shop mate had a pair of micrometers, the faces of which had become considerably worn. He procured a small piece of plate glass and placed a few drops of oil and flour of emery upon one side, while the other remained perfectly clean. The micrometers were then closed lightly upon the glass, which was slid back and forth between the jaws for quite a little time. Then, after thoroughly cleaning the first jaw, the glass was reversed and the process repeated upon the other jaw. In a short time the micrometers, so far as the jaws were concerned, were as good as ever. ROY W. HARRIS.

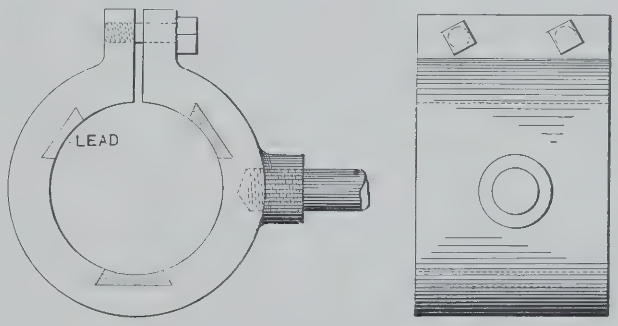


Fig. 4. Lap for Plug Gages.

Salem, Ohio.

FIXTURES FOR MULTIPLE MILLING.

Editor MACHINERY:

Sometimes a simple operation like splitting a piece of work in two will be found to present difficulties equal to those encountered in much more complicated operations. One such a case was met with in machining the pieces shown in Fig. 1, which were to be split in two along the line *X Y*. Owing to the peculiar shape of these pieces it was impossible to clamp them in any position so as to mill more than a single one at a time and as a large quantity were to be made it was desirable to arrange so as to cut a number at a single operation. For this purpose the jig shown in Fig. 2 was constructed and with this ten pieces could be cut at a single setting.

This fixture consisted of a casting *A* which was provided with a tongue for aligning it upon a milling machine table, and a slot at either end for receiving a clamping bolt. A series of holes, of the same size as that in the work, was drilled in the upper part of the fixture, and to insure their being parallel with the tongue, the drilling was done in place upon the milling machine, the vertical attachment being used. These holes were fitted with the studs *B B*, which were of sufficient length to extend through the work *C*, as shown in the section. On the bottom of each stud was placed a split washer and nut, the latter being small enough to pass through the hole in the jig and work. These studs were prevented from turning, when the nut was tightened, by means of a setscrew *D*, the point of which fitted a slot in the side of the stud. A similar slot was also cut in the side of the nut so that it could pass the setscrew. A slot *E*, the width of the splitting saw, was cut through the top of each stud and the setscrew *D* insured this slot being always in proper position for the saw to pass through when splitting the boxes.

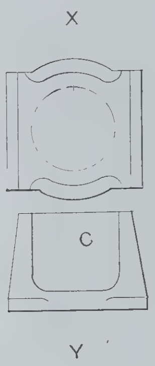


Fig. 1. One of the Pieces.

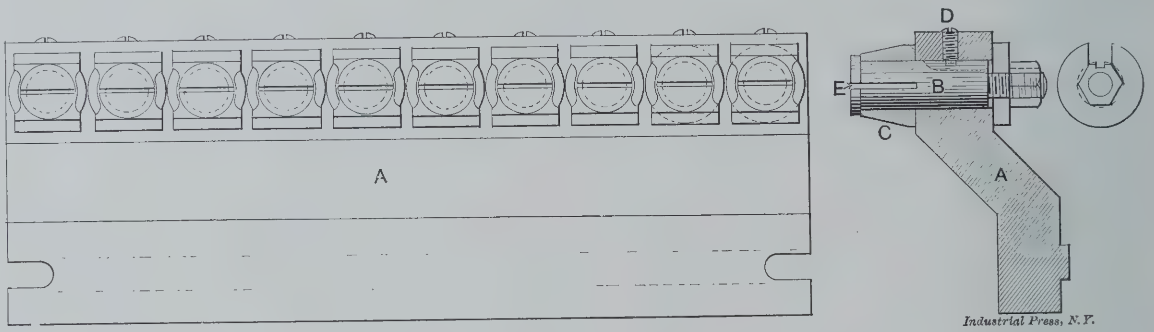


Fig. 2. Fixture for Splitting ten Pieces at once.

Before the pieces were placed in the jig they were bored and faced on the top, bottom and on the straight sides, so that the splitting formed the last operation. Ten of the pieces were placed on the fixture, the bolts *B* put through and the washers put in place. Before tightening the nuts a straightedge was placed along the front side of the pieces so as to set them all squarely, after which the nuts were tightened and the saw passed through the group in the usual manner.

Charles P. Thiel.

Lawrence, Mass.

THE PRINCIPLES OF PSEUDO-PERSPECTIVE IN PRACTICE.

Editor Machinery:

The article in the July number of Machinery entitled "The Theory and Application of the Principles of Isometric Drawing," by A. B. Babbitt is undoubtedly in keeping with the tendency of the times in modern drafting room practice. The importance that was formerly placed on true perspective is, or should be, fast disappearing in practice, as the camera, with proper manipulation, will do a far better job than any artificial mechanical method. In the commercial working, drawing with the usual orthographic representation of the object, a large number of meaningless conventions used for picture effects and mis-called "systems" are being replaced by heavier and plainer lines which are described by unmistakable dimensions and good every-day Anglo-Saxon; all of which things are in harmony with this most practical age. The spirit of commercial drafting is to make a working drawing of an object clear and well represented, with a minimum number of lines and views; hence, in the average practice a symmetrical object is often satisfactorily shown in one view while, on the other hand, an intricate angular object will require several views.

Recently some few commercial drawings have been seen which made use of the pseudo-perspective projection, which gave a clearer conception of the form of the object than an orthographic projection would have done, and with no greater expenditure of time than there would have been in making the several necessary views in orthographic. Patent Office drawings, especially when the invention is illustrated in the Patent Office Gazette, require occasionally a descriptive view of the object which cannot be shown in orthographic projection. Perspective or pseudo-perspective must then be resorted to and the latter will save much time if mechanical means are used. The article referred to has, in isometric projection, treated only one species of pseudo-perspective. Omitting a descriptive of geometry definition, it may be said that all projections, when referred to and governed by the position of axes would come under the term axometric projection. Thus isometric projection is defined if the axes are taken at 120 deg. with each other regardless of what angle any one of the axes makes with the vertical or horizontal. Cabinet projection is specifically defined by the angles that the axes make with each other, which are 90 deg. and 45 deg., and their position should be horizontal and vertical and with the 45 deg. line half the true length of the corresponding line in the object. Axes can be selected which make any angle with each other and take any position with reference to a horizontal or vertical, with results which are sometimes as satisfactory as the conventional isometric. However, the axes should be selected with reference to convenience in drawing the lines, which fact would indicate that horizontal, vertical, 15 deg., 30 deg., 45 deg., 60 deg., and 75 deg. lines are to be selected in some combination of three, on account of the gain in convenience in the use of the triangles and T-squares. The proper combination to suit each case belongs more properly to the science of descriptive geometry or to the art of the skilled draftsman.

There is occasionally found among draftsmen an artist who needs no axes and consequently no knowledge of axometric projection but, with a free hand, can lay in his lines to better effect than his brother draftsman who uses mechanical means. He, however, loses the great advantage which is sometimes gained by drawing to a working scale in axometric. After the axes have been selected, the fundamental rule that all parallel lines in the object are parallel in the drawing must be observed, unless a better picture effect is sought, which will occur quite infrequently.

C. E. Coolidge.

Ithaca, N. Y.

* * *

In the case of most cast-iron machine parts that have to go through the operations of planing, boring, drilling, etc., the usual procedure is to first plane the piece and then do the other operations, as then there are truly plane surfaces to work to. This, however, only holds when the holes to be bored are relatively small as compared with the size of the piece. When there is only one bore of large relative size like that of a steam cylinder, the cylinder is first bored and then planed. This is especially true of the practice followed in making locomotive cylinders. The boring bar must be set with special reference to the cored hole so that it will clean up, and the planing surfaces, which are certain distances from the bore, must take care of themselves.

ITEMS OF MECHANICAL INTEREST.

MAMMOTH STEEL FREIGHT CAR—OFFICE TELEPHONE SUPPORT—STEEL ELEVATOR GUIDE—PERMANENT IRON MOLDS—ADJUSTABLE SOCKET WRENCH.

It appears that bolts, nuts and other ordinary screwed connections traversed by an alternating electric current, are very likely to loosen in time even if so situated as to be unaffected by the ordinary mechanical vibrations of running machinery. The cause for this phenomenon seems obscure, as no satisfactory explanation has ever been made of it so far as we know.

Experiments by J. Parker Whitney in Oregon upon the preservation of food products by freezing, indicate that live fish may be frozen and thawed back to life again if not exposed to the sun or allowed to get more than 12 to 14 degrees below the freezing point. If exposed to zero temperature they will not survive as the faint pulsations of life then cease. This has led to a project for the shipment of live salmon to the Atlantic coast and we may yet have planked live salmon in New York City.

A valuable feature of the electric motor where it is coupled direct to a shaft having end thrust, is that it may be so designed that the magnetic pull of the field coils upon the armature shall be longitudinal to its axis as well as tangent to its periphery. The longitudinal pull may be so proportioned as to entirely balance the end thrust, provided it is not too great, of course, and in this way the loss due to the friction of a thrust bearing may be eliminated. This feature of the electric motor is of special value in high-speed machinery like office fans, and it is in them that the principle is largely employed. The end thrust due to the fan action is not great, but the fan revolves at high speed, and if there was the friction of a thrust bearing to overcome, the mechanical efficiency would be considerably reduced.

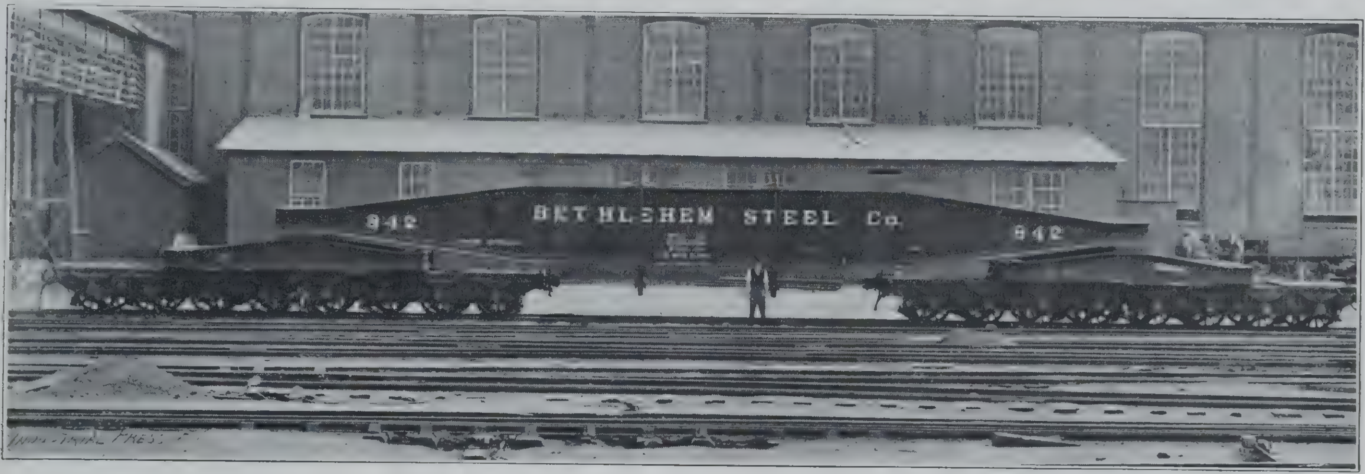


Fig. 1. Steel Freight Car of 300,000 Pounds Capacity.

Several times within the past few months we have referred to certain nickel-steel alloys (about 36 per cent. nickel), having a very low coefficient of expansion, say, one-thirteenth that of steel. But M. Guillaume, assistant director of the International Bureau of Weights and Measures, who has been for several years making a special study of these alloys, now states that nickel-steel wire has been made having so slight a degree of extensibility within the ordinary ranges of temperature, that this is only discoverable with very accurate means of measurement. Between the temperatures of 32 and 68 degrees Fahrenheit the expansion is said to be only about one-fortieth of an inch in one mile length. It is also stated that a nickel-steel alloy has been made that actually contracts with heat like rubber, but this is presumably true only within narrow limits.

When the trains were first started on the Boston Elevated railroad there were many complaints because of the noise made by them in passing over the elevated structure. This noise was louder and more objectionable than experienced with the elevated trains in New York City. In Berlin, Germany, there has been similar trouble and the railroad company has been compelled, through legal measures, to resort to every practicable means for reducing the vibration and deadening the roar of traffic. Experiments were conducted which included, first, inserting three layers of felt between the rails and the wooden ties on which they were laid. This did not satisfy the complainants, although it made some improvement. Next, in place of wooden sleepers, hollow iron girders were put beneath the rails and filled with loose sand, which, it was expected, would take up the vibration and thus deaden the shock. This, also, has been found partially effective, but not wholly satisfactory. A third plan has been to abandon the use of cross-ties and instead lay the rails on long longitudinal wooden sleepers, with cushions of lead laid beneath the rails. Finally, the car wheels have been in some way lined with wood, so as to break the continuity and consequent resonance of a metallic structure. All these experimental remedies are still on trial, but no definite conclusion concerning them has been announced.

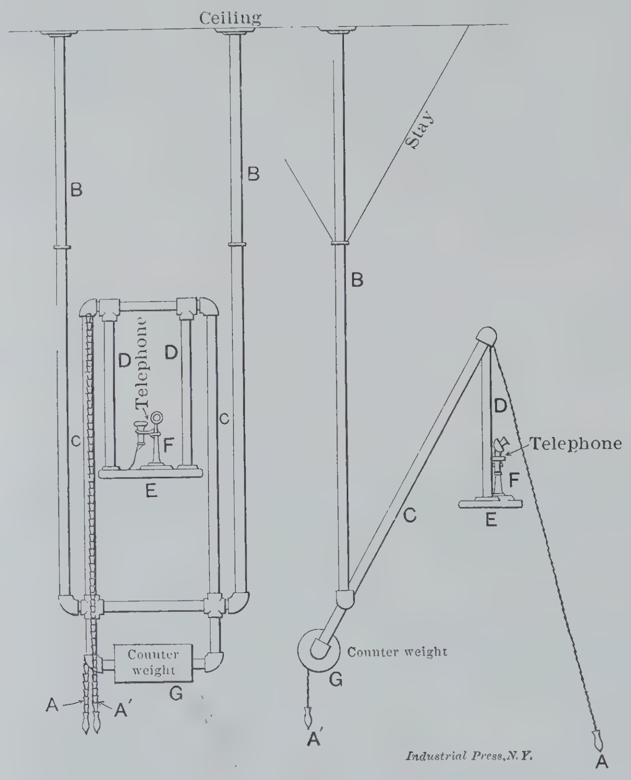
STEEL FREIGHT CAR OF 300,000 POUNDS CAPACITY.

A cut appeared in the June issue showing the boring of the bolt holes in a huge steel casting weighing about 250,000 pounds at the works of the Bethlehem Steel Co. This casting is one forming part of a 12,000-ton armor plate forging press being built by this company for the Carnegie Steel Co. In the same connection mention was made of a special freight car being built for the purpose of transporting these enormous castings, one of which weighs 325,000 pounds, to Pittsburg. The accompanying cut, Fig. 1, shows a view of the car, which has since been completed and dispatched with a load of two smaller castings, the aggregate weight of which was 277,000 pounds. The length of each casting is 21 feet 4 inches; width, 2 feet 8 inches; height, 11 feet 6 inches. The large casting shown in the June issue is 24 feet 4 inches long; 5 feet 2 inches wide, and 13 feet 2¼ inches high. The large dimensions, especially the height, made it imperative to provide a special car, fully as much as the great weight. To clear bridges and tunnels it is necessary that the castings be carried vertically, and to accomplish this the body of the car consists of two steel trusses, 66 feet 10 inches long and 6 feet high, between which the load is swung. The trusses are supported at each end by two sets of eight-wheeled trucks, making 32 wheels in all. The main trusses are pivoted on king-bolts which are 64 feet apart center to center, and the short trusses or equalizers at the ends, distribute the load to the centers of the eight-wheeled trucks, which are also pivoted on king-bolts. The trucks themselves are provided with springs and equalizers so that the load is uniformly distributed among the 32 wheels.

The total length of the car is 103 feet 10½ inches; height, 10 feet 2¼ inches; width, 9 feet 9 inches; weight, 196,420 pounds; capacity, 300,000 pounds. The car was built by the Bethlehem Steel Co., at South Bethlehem, Pa.

CONVENIENT OFFICE TELEPHONE SUPPORT.

There are quite a variety of telephone supports for desk use, good, bad and indifferent, but the most novel and in some respects the most convenient we have seen is a home-made affair in the private office of the Detrick & Harvey Machine Co., Baltimore, Md. A double flat desk is used for the two partners and it was necessary to arrange the support so that the telephone would be equally accessible for both. The illustrations, Figs. 2 and 3, show front and side views of the construction so clearly that little description is required. The frame is constructed entirely of pipe and pipe fittings, the side members *B B* being one-half inch size. The upper ends of these pieces are fastened to the ceiling directly over the center of the flat-top desk and are stayed by wires. Pivoted on the cross-bar at the bottom is a closed frame *C C* having a counterweight *G* at the bottom. The telephone support is composed of a board *E* upon which the instrument *F* is set, and the pipe members *D D*, which are pivoted on the upper cross-bar. Two flat link chains *A A′* are oppositely attached to the upper end of the counterweighted frame to pull the telephone down to the level of the user. Fig. 2 shows the frame being swung down by the chain *A*.



Figs. 2 and 3. Office Telephone Support.

A COMPRESSED STEEL ELEVATOR GUIDE.

In the erection of elevators much trouble is ofttimes experienced in procuring proper guides for the cars, while recent building laws calling for the use of steel for this purpose have produced a demand for a steel guide that shall fulfill the requirements with satisfaction. The production of such guides by the ordinary machining methods is one of considerable difficulty since they require to be perfectly straight and of sufficient length to avoid too numerous joints. These conditions are such as to make the steel compression process admirably fitted to their production. The sketch illustrates a guide that is now being made, of open hearth steel, by this process and which can be produced in lengths up to 19 feet. This method of finish gives a uniform size throughout the entire run and produces a smooth, hard running surface that is easy to clean and greatly reduces the friction of the car.

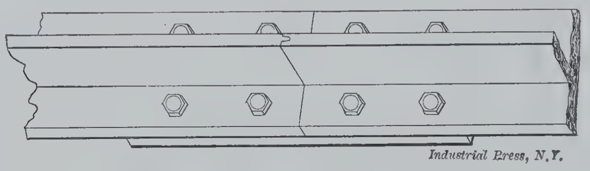


Fig. 4. Compressed Steel Elevator Guide.

The matter of the joint has received especial attention as it is usually at this point that trouble with the ordinary guides is likely to ensue. To make a smooth and rigid joint, in the lower ends of each length is milled a groove which is fitted to receive a corresponding tongue cut on the upper end of each length. The lengths are then matched, as shown in the cut, so that the tongue insures rigidity and prevents any possibility of one end bending over or slipping by the other thus breaking the joint. The ends are held together longitudinally by means of fishplates bolted on the back side and as the rails and plates are all drilled to standards the erection of the guides is greatly facilitated. They are made by the Standard Gauge Steel Co., Beaver Falls, Pa.

THE USE OF PERMANENT MOLDS.

In a paper on permanent molds read by James A. Murphy before the American Foundrymen's Association at Milwaukee, Wis., June 9-11, it was stated that loam molding has reached a high degree of perfection in this country, and that more and more attention is being given to the saving as much as possible of each mold in order to reduce the cost of the castings made. In other words the permanent mold is the object sought. Large kettles, pans, domes, pipes, etc., are classes of a type of work that can be made cheapest in permanent loam molds. The paper illustrates a mold for a kettle weighing fourteen tons that will last for several years' continual use, turning out a kettle every few days. The core is swept up and is preferably dried in an oven. A pit is dug in the floor in some convenient location and the binders *A* and the bottom plate *B* are set in place; and the spindle step *C* for the mold sweep by which the interior of mold is swept up. The brickwork is laid so as to allow a thickness of from ½ to ¾-inch of loam. If the bricks are not of good quality, it is best to use firebrick for the face. Upon the top of the wall is placed a strong cast iron ring *E*, which is recessed to clear the eight iron frames *D*. These latter are for the reception of cores for handles, brackets or other projections, and can be removed without disturbing the wall. Other details as explained in the paper are such as to avoid the disturbance of the brickwork when a casting is stripped. As a whole this paper should be of much interest to foundrymen.

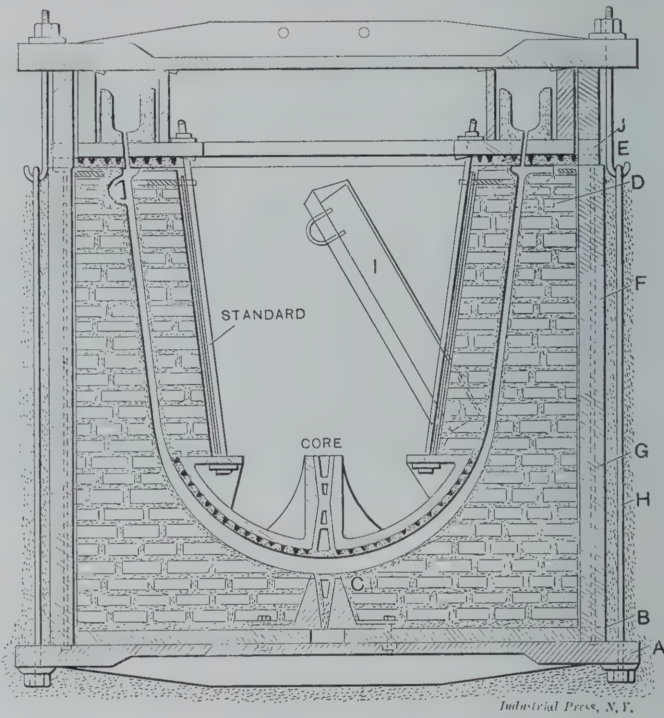


Fig. 5. Permanent Mold for Iron Kettle.

SOCKET WRENCH WITH ADJUSTABLE STEM.

In the average machine shop a set of socket wrenches ordinarily represents a somewhat expensive equipment that is rarely used, but the need of which is so urgent when they are wanted that they must be kept at hand. For the usual run of work the socket wrench cannot be conveniently employed so it is relegated almost entirely to the special work for which it is designed. But by jointing the stem *B*, Fig. 6, where it joins the socket *A*, the usefulness of this class of tools is greatly increased, as they may then be used for their designed purpose and for work that the ordinary socket wrench cannot handle. For example, by loosening the binding screw *C*, which is ordinarily set up tightly, the stem is free to move on a pivot, and then a nut or screw can be turned when located under a ledge, the connection acting as a sort of universal joint. The stem, in such cases, assumes an angular position, say, *B′* in the lower view. Again by locking the binding screw with the stem *B* in a right angle position, we have a fairly good substitute for the "box" wrench, especially if the stem or handle is made somewhat longer proportionally than indicated in the cut. But perhaps the most valuable feature possible in this combination is that the sockets and stems can be made interchangeable, thus making it possible for one set of each to cover all probable requirements.

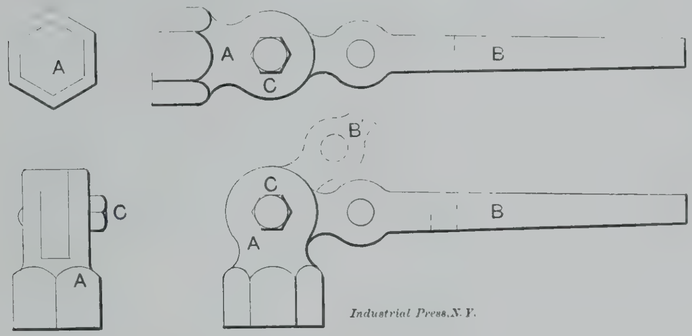


Fig. 6. Adjustable Stem Socket Wrench.

COMPARATIVE EFFICIENCIES OF STEAM PUMPS AND STEAM TRAPS.

In the catalogue of the American Blower Co., Detroit, Mich., which deals with the Morehead steam traps of their manufacture, is given a comparison of the efficiencies of steam pumps and steam traps for returning water of condensation to the boiler, from which we quote. These traps operate on the gravity principle, have steel tanks and will return the condensation from either above or below the water line of the boiler.

A pump will not lift water at a temperature exceeding 212 degrees; a return trap will. A pump consumes an extravagant amount of steam to do very little work. For example, an ordinary duplex boiler-feed pump requires from 90 to 120 pounds of steam per horse-power hour. A common slide valve engine seldom consumes less than 40 pounds per horse power. A return trap consumes less than 10 pounds per horse power. The pressure is admitted to the surface of the water, and is automatically shut off before the tank is empty. The steam used is only such as is condensed by the latent heat passing from it into the water in the tank, which is all put back into the boiler.

A return trap requires no attention further than to repack the gland, perhaps once a year, and to tighten same about every three months. It requires no cylinder lubrication; will not race or run away; never sticks; is noiseless; requires little room and no foundation; in fact, a pump has no feature in which a return trap is not superior.

Assume the steam pressure carried is 100 pounds, and all condensation is cooled to the temperature of the feed water, is passed through a feed-water heater, and is then pumped into the boiler by a boiler feed-pump at a temperature of 200 deg. The total heat in water raised from 32 deg. to 200 deg. is 168.75 B. T. U. The heat in steam at 100 pounds pressure is 1,185 B. T. U. Thus, to raise one pound of water from 200 deg. to 100 pounds pressure has required the addition of 1016.25 B. T. U.

Supposing, again, the condensation is returned to the boiler by a return steam trap instead of a pump. With a return trap the condensation will not be cooled below the temperature of the steam at which it is condensed, which in this case is 337.8 deg. The heat in water at this temperature is 309.5 B. T. U. Therefore, to evaporate the water into steam at 100 pounds pressure will require 875.5 B. T. U. Thus the saving is the difference between 1,016.25 and 875.5, amounting to 140.75 B. T. U. per pound of water, or nearly 14 per cent.

This does not take into account any losses by radiation, leakage, etc., but these would apply to either a pump or a trap, and owing to the greater amount of steam required to operate a pump, as already shown, the net gain would be considerably more. If the temperature of the feed water was only 100 deg. instead of 200 deg., as above assumed, a return steam trap would show a net gain of more than 20 per cent.

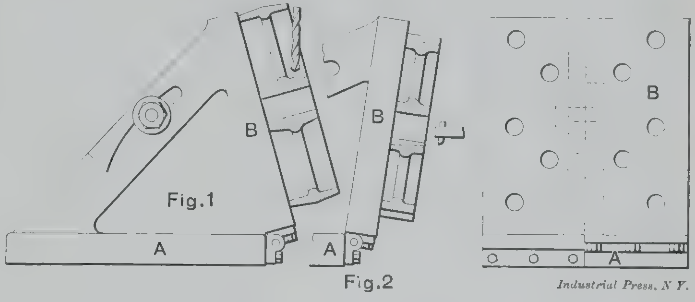
Apply the above to a plant of 200 horse power, having an efficiency of 65 per cent. and an evaporative capacity of 6,900 pounds of water per hour from and at 212 deg. Burning coal containing 13,000 H. U., one pound should evaporate about 8.3 pounds of water from 200 deg. and 9.65 pounds when returned to the boiler at 337.8 deg. To evaporate 6,900 pounds of water per hour from and at 212 deg. Burning of coal per hour, the latter representing a saving of 115 pounds of coal per hour. This saving on a day's run of ten hours for 200 days—this being about the heating period for a year—will amount to 115 tons. At $2.50 per ton, it will amount to $287.00, more than twice the cost of installing a trap large enough to handle a plant of this size.

* * *

CONTRIBUTED NOTES AND SHOP KINKS.

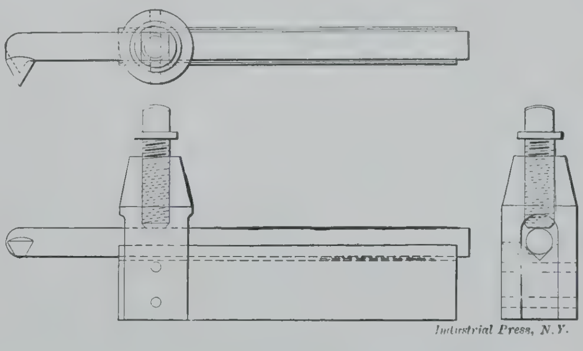
AN ADJUSTABLE ANGLE PLATE.

The sketch of the adjustable angle plate, contributed by A. McA., shows a shop appliance that will be found very handy in a large number of cases for use on planer, shaper or drill. For shaping any work at given angles, planing taper keyways, drilling oil holes in pulleys, or any work of this nature the fixture is readily adapted. It consists of a base *A* to which is hinged the face *B*, drilled with numerous holes for fastening on the work. A back rib on the base carries a clamping bolt which runs through a slot in a corresponding rib on the back of the face piece, and by which the two are clamped together when they have been set at the required angle. The sketch shows the plate set for drilling oil holes in pulleys and also, in Fig. 2, how it is arranged on the planer for planing taper keyways.



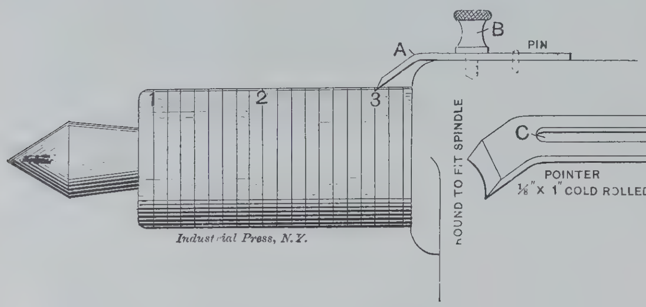
A DEEP BORING AND THREADING TOOL.

It often happens that a job comes up requiring a comparatively long and small hole to be bored and perhaps threaded, for which purpose it is customary to have the blacksmith draw out a special tool. To save this trouble such a tool as is shown in the sketch, sent us by E. H. R., will be found very convenient. The shank is made to fit the toolpost of the lathe while the cutter may be set out to any length and firmly clamped by tightening up the setscrew. Since the cutter is independent of the shank the height of the cutting point can be easily raised or lowered by simply turning the cutter bar before it is tightened up. This tool is especially handy for use on odd-sized holes and special threads for which reamers and taps are not provided.



GRADUATIONS ON THE TAILSTOCK SPINDLE.

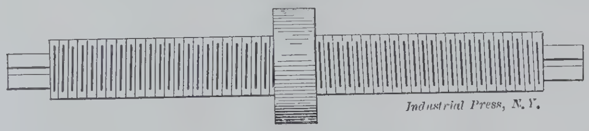
R. A. L. sends a "kink" regarding an improvement for the lathe tailstock which, he thinks, might well be adopted by the lathe builders. In order to drill holes to a required depth, in work held in the lathe chuck, some sort of a mark must be made on the drill or measurements taken on the tailstock. Marking the drill is rather unhandy on account of its being hardened, so the scheme of graduating the tailstock spindle will be found much more convenient.



To prepare the tailstock for this arrangement, the spindle is taken out and put on the centers of a lathe which is geared for cutting eight threads per inch. A sharp pointed V-tool, placed in the toolpost, is used as a scriber and the spindle is rotated by hand until a sufficiently clear circle is cut upon it. The cone of the lathe is then given one complete turn, thereby moving the tool ⅛ inch, and the next circle is scribed in a similar manner to the first. This is continued until the spindle has been graduated for its entire length. Beginning with 1, the even inches are now stamped with their respective numbers and the spindle is replaced in the tailstock. The pointer *A* is clamped to the top of the tailstock by the thumbscrew *B* and a slot *C* allows the pointer to be moved backward and forward when the screw is loosened. In drilling a hole, as soon as the full diameter of the drill enters the work the pointer is adjusted to the nearest even inch mark and clamped. The depth to which the drill is fed is then read directly from the graduations on the spindle.

A SHOP APPLICATION OF ELECTRIC WELDING.

A. D. K. writes: Some time ago it became necessary to repair twelve chuck screws such as are shown in the accompanying sketch. They were ⅝ inch in diameter with heads squared down to the bottom of the threads. These heads had worn round on the corners and in some cases they were twisted nearly off while the threaded portion of the screws were as good as ever.



To repair them I cut the old heads off within ⅛ or 3-16 inch of the threads; then short pieces of tool steel, large enough to form the square of the heads, were welded on in the electric welding machine. The heads were then squared up and hardened and the screws were as good as new, the entire time consumed in making the repair being only about one hour.

A KINK IN DIVISION.

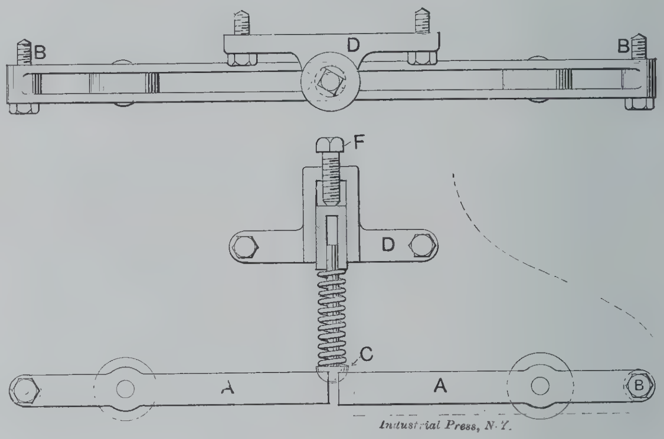
Clay-Beau sends a "kink" for dividing fractions regarding which he writes: By the machinist and apprentice no arithmetical operation is more frequently encountered than the division of inches and fractions thereof by two, as in laying off center lines, spacing, etc. While the division of an even number and a fraction by two is easy enough to almost any one, it is surprising to note how much "fussing" is done by many over the division of an odd number and a fraction. My attention was recently called to the following method which, although it may not be new to all of the readers of MACHINERY, will, I am sure, prove very convenient to those who have never used it.

To divide an odd number and a fraction by two, write the expression in the ordinary manner, draw a line beneath it and add together the numerator and denominator of the fraction, placing the sum in position for the numerator of the fraction of the quotient. For the denominator of this fraction multiply the denominator of the fraction which is being divided, by two. Deduct one from the whole number of the expression that is being divided and divide the remainder by two. The following examples will show clearly how the method is operated.

$$\frac{31\frac{31}{32}}{15\frac{63}{64}};\quad \frac{1\frac{1}{32}}{\frac{33}{64}};\quad \frac{7\frac{19}{33}}{3\frac{52}{66}};\quad \frac{19\frac{57}{141}}{9\frac{198}{282}}$$

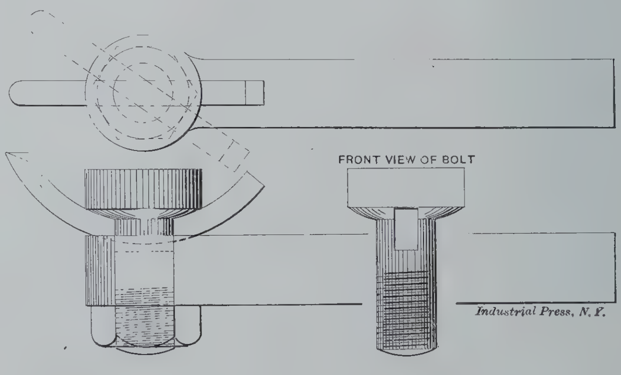
A TAILSTOCK TRUCK.

"Student" sends us a sketch of an attachment which he uses on heavy tailstocks to facilitate sliding them along the bed of the lathe. On either side of the tailstock is fastened the frame *A A*, by means of the tap bolts *B B*, and two rollers are mounted on journals near the ends of each frame. The frames are cut in two in the center and the plunger *C* fits into a socket, part of which is formed in each half of the frame. A bracket *D* is fastened to the side of the tailstock, above each frame, and the pressure of the spring is so adjusted by means of the setscrew *F* that the weight of the tailstock is supported on the rollers. It is clamped to the bed in the usual manner, but as soon as the clamps are released, preparatory to moving the tailstock, the force of the spring raises it at once onto the rollers so that it may be easily slid to any place on the bed that is desired.



A HOLDER FOR USING CURVED TOOLS.

E. J. B. sends a sketch of a novel holder for inserted tools, to be used on lathe, planer or shaper, which, he says, is giving better success than anything he has ever used before. The tool is curved to a radius of three or four inches and the boss on the shank is turned out to fit the outside or bottom curve of the tool, while the clamping bolt fits the top radius. As will be seen by the sketch, by pushing the tool forward or backward any desired rake can be obtained, while the blade may also be swiveled at any angle for right or left hand use, as indicated by the dotted view. For holders to take ⅜ or ½-inch self hardening tool steel the bolt head and boss on the holder should be about 1¾ inches in diameter.



HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

30. F. H.: How are the various dimensions of the teeth of the large gear made by the Bethlehem Steel Co., as mentioned in the June issue, figured? What is the outside diameter and does 6⅛-inch pitch mean circular pitch?

A. The pitch diameter is 20 feet 9.55 inches, or more exactly, 20 feet 9.554 inches. Expressed in inches the pitch diameter is 249.554 inches, and multiplied by 3.1416 it equals 784 inches pitch circumference nearly. Dividing 784 by 128 teeth gives the circular pitch, or 6⅛ inches. To change this to diametral pitch, divide by 3.1416 or multiply by 0.3183. Dividing 6.125 by 3.1416 (or multiplying by 0.3183) equals 1.95 nearly, which is the module for 6.125 inch pitch, or 1.95 inches diametral pitch. Since it is the general practice to make the addendum face equal to the diametral pitch, it is only necessary to multiply the diametral pitch, 1.95 inches, by 2 and add the result to 249.554 in order to get the outside or addendum diameter. $249.554 + (1.95 \times 2) = 253.45 +$ inches outside diameter.

31. W. C. W.: Can aluminum be cast in steel molds and produce smooth accurate castings that will require no finishing?

A. The Pittsburg Reduction Company inform us that aluminum can be successfully cast in metal molds provided they are heated quite hot before pouring the metal. Better work can be produced this way than in sand molds. Aluminum melts at a temperature of about 1,250 degs. Fahr., and shrinks in the mold somewhat more than cast iron and less than brass. The heating of the mold partially compensates for the shrinkage so that the cavity need not be made the full shrinkage allowance larger. The principal reason for heating the mold, however, is to prevent injury to the piece, which would otherwise be likely to occur on account of the unyielding nature of metal molds as compared to sand. The degree of accuracy that you require will determine whether the castings produced in this way will meet your requirements. The H. H. Franklin Mfg. Co., Syracuse, N. Y., make metal castings (not aluminum) in metal molds, absolutely true to gage and these are being largely used in the manufacture of cash registers and other apparatus needing a large number of duplicate parts difficult to machine and which must be true to gage.

32. N. A. S.—Will you kindly give me information regarding the thickness of metal for common valves, such as globe valves, etc.? For metal I wish to use a composition of copper, 88 per cent., tin 10 per cent., zinc 2 per cent. 2.—How thick should a globe valve be, 8 inches diameter, to be used under a head of water of 14 feet?

A.—The rules used by manufacturers of valves are purely empirical. If the thickness of the walls were calculated by the ordinary formula for the strength of a cylinder, it would be amply strong to stand the pressure, because a valve is more or less spherical in shape, and is reinforced by flanges, webs, etc. But a valve would actually be made heavier than this, because it is so irregular in its form that the strains incident to cooling in the mold might crack or at least weaken it. Just how much to allow for this is a matter for the designer to decide. In the data sheet with the Engineering Edition of MACHINERY for October, 1902, was published some information with regard to the practice of the Crane Company in valve design. For 6-inch pipe they use thicknesses of ½ inch, 9-16 inch, and ¾ inch for light, medium and heavy valves, respectively; for 12-inch pipe, ½, 13-16, and 1 inch; and for 24-inch pipe, ¾, 1¼, and 1½ inch respectively. Your composition will probably be about 25 per cent. stronger than cast iron, and you will be safe in assuming a tensile breaking strength of 20,000 pounds per square inch. The rule for thickness of pipe above mentioned is: Multiply pressure in pounds per square inch by diameter in inches, and divide this result by twice the tensile strength. Allow a factor of safety of six. 2.—Your valve, to withstand a head of water of only 14 feet, can be made light as can be cast in the foundry, say ⅜ or ½ inch thick.

33. M. P. C.—What are the best rates of flow for water, air and steam through pipes? There must be some happy medium in the items of cost, length, friction, etc., for pipes of ordinary length. What I want is three figures, one each for water, air, and steam, which shall express the best or customary speeds for each of these.

A.—It is common to proportion the delivery pipes of pumps so that the flow shall not be over 400 feet a minute—preferably less. The old and reliable figure for steam pipes is 6,000 feet per minute. In air transmission, the carrying pipes are usually much smaller than steam pipes used for steam engines, etc., and the distances of transmission are generally much greater than with steam, so that 1,200 feet may be taken as a maximum figure. We do not consider, however, that any figures could be given that would answer your question properly. The loss from friction in transmission depends upon so many different elements, such as diameter and length of pipe, number of elbows and valves, velocity, pressure, etc., that no judgment should be rendered in any particular case until a calculation had been made, using the best available data at hand. Calculations for flow of water can be made with considerable certainty of result, and very clear directions are given for these in Merriman's Hydraulics, published by Wiley & Sons, New York. For the flow of steam the following formula may be used, based on experiments by Prof. Carpenter of Cornell:

$$p = \frac{w^2 l \left(1 + \frac{3.6}{d}\right)}{7500\, D\, d^2}$$

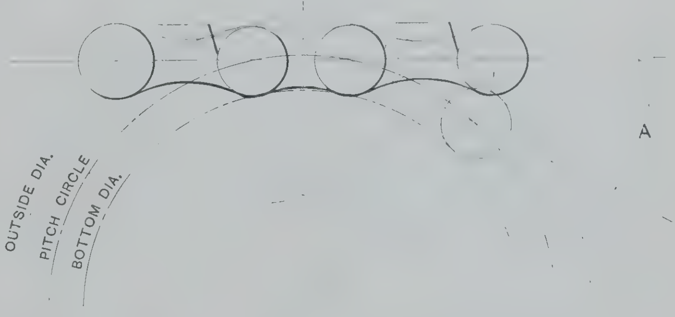
$p =$ fall of pressure in pounds per square inch.
$w =$ pounds steam discharged per minute.
$l =$ length of pipe in feet.
$d =$ diameter of pipe in inches.
$D =$ weight cubic foot steam at the lower pressure.

For the flow of air we will refer you to Kent's pocketbook; also to catalogues of air compressors.

Question No. 28 answered by C. E. Coolidge, Ithaca, N. Y.

The contributor of question No. 28 asks for a simple method for determining the pitch diameters of sprocket wheels when the chain block, side links and number of teeth are the known factors. I take the liberty of submitting the following graphical method which, I believe, is far more satisfactory than the long computations involved in the formulas given in Brown & Sharpe's catalogue:

Suppose in Fig. 1 a design of the tooth, chain block and side links of a segment of the sprocket are shown laid off on a straight line either on paper, wood or metal. Then, knowing the number of teeth and the fact that the center lines of the links and blocks make equal angles when laid off as chords on the pitch circle, it is evident that the angle, A, is known from the well known proposition in geometry that the sum of the exterior angles of a polygon are equal to four right angles. Hence, if n represents the number of chords made by the center lines of links and blocks then the angle $A = \frac{4 \text{ x } 90.}{n}$



Industrial Press, N.Y.

Fig. 1. Laying Out Sprocket Wheel.

The value of the angle *A* can be taken from the accompanying table which gives the different values of the angle corresponding to the number of teeth on the sprocket. These angles are shown in Fig. 2, each marked with the corresponding number of teeth and they can be laid off in Fig. 1 by transferring, without the use of the protractor or other construction.

TABLE OF EXTERIOR POLYGONAL ANGLES.

Number of Teeth.	Angle A.	Number of Teeth.	Angle A.
6	30.	18	10.
7	25.71	19	9.47
8	22.50	20	9
9	20.	21	8.57
10	18.	22	8 18
11	16 36	23	7.83
12	15.	24	7.5
13	13.84	25	7.2
14	12.86	26	6.93
15	12.	27	6.67
16	11.25	28	6.43
17	10.59	29	6.21
		30	6.

Having laid off angle *A*, the center of the pitch circle which passes through the vertices of the angles formed by the chords is found by the usual geometrical construction which consists in locating the point of intersection made by the intersection of the perpendiculars to the middle points of the chords. The bottom and outside circles of the sprocket wheel are drawn tangent to the arcs bounding the ends of the block.

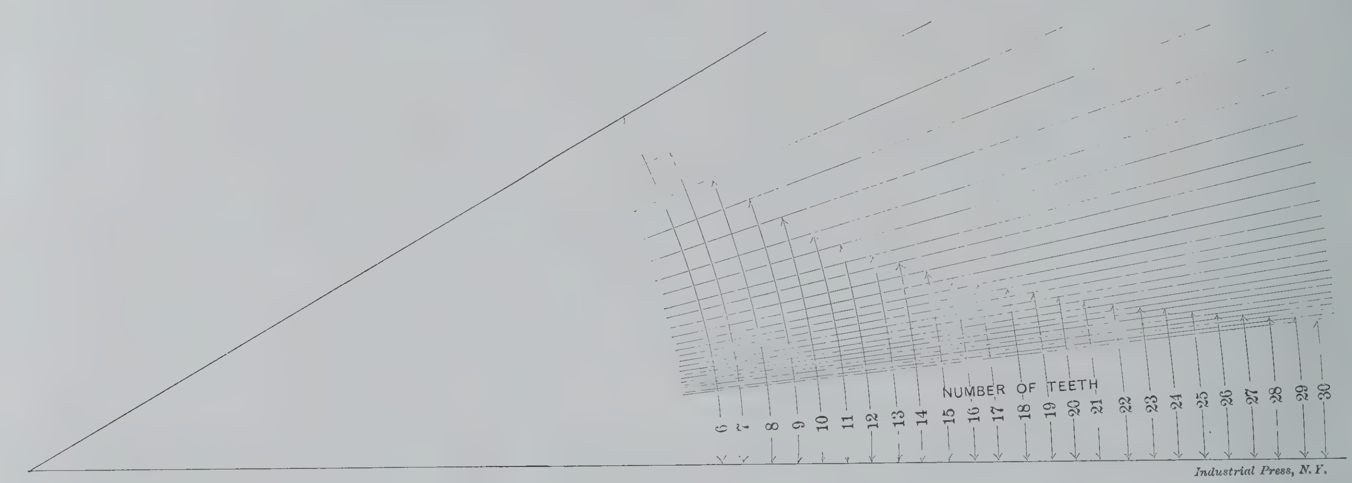


Fig. 2. Angles for Laying Out Sprocket Wheels.

* * *

MAKING CYLINDER HEAD COVERS ON A STEAM HAMMER.

The general practice in railway shops relative to cylinder head coverings is now to make them of pressed steel instead of cast-iron as formerly prevailed. The pressed steel casings are not only much neater in appearance, but much more durable, as it is practically impossible to break them and even if badly bent they can usually be straightened out so as to fulfill their function satisfactorily. The ordinary process of making pressed steel work of this description requires a hydraulic press, a machine that is rarely found in the average railway repair shop. But the Lehigh Valley R.R. shops at Easton, Pa., impressed a double-column steam hammer into this class of work with very good results and at an expense for special equipment, quite trifling. Cast-iron male and female dies are provided for the different sizes required, and these are made with a dovetail on the back to fit the hammer and anvil, as at *A* and *B*, Fig. 1. A hole is first drilled or punched in the sheet designed for the casing and then it is trimmed to circular shape, on a circular slitting shear. After being heated in an oil furnace the disks are laid on the female die with the vertical pin *E* projecting through the hole in the center. A hole is provided in the die *A* so that the pin is not disturbed when the blows are struck.

In these shops, and presumably in others of the same system, it is the practice to fit driving wheel axle keys on the sides only. The keyway is located, as shown at *D* in Fig. 2, and not at *D′* as is the usual practice. We believe the practice followed by the Lehigh Valley R.R. people in the location of this keyway is based on sound principles. It is better to place the keyway where the metal is under the least initial stress and that is undoubtedly on the side of the axle *A*, opposite the crankpin *B*. Nine-tenths of the wheel centers that crack in service having the keyway located between the axle and the crankpin, will be found to have the crack radiating from one corner of the keyway to the crankpin hole. With the keyway oppositely located the metal is not removed from the spot where it is most needed. As already stated, the keys are fitted sideways, no attempt being made to have them fill top and bottom. In fact the reverse is the case, clearance to the extent of about 1-32 inch always being allowed. The keys are fitted by the planer hand, no hand fitting by filing being done. This, of course, does away with the time-honored practice of having a key forged on the end of a heavy bar with an overhanging head. The number of times a key, fitted in this manner, will be driven in and hammered out by striking under the head depends on the patience of the fitter and his idea of how much time he should put on the job. The machine-fitted key is much better in every way and of course considerably cheaper in cost.

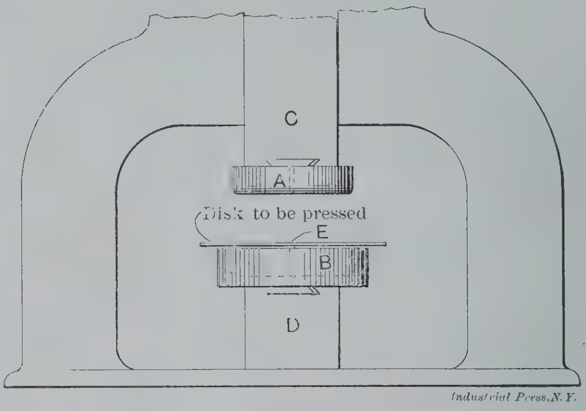


Fig. 1. Making Cylinder Head Cover on a Steam Hammer.

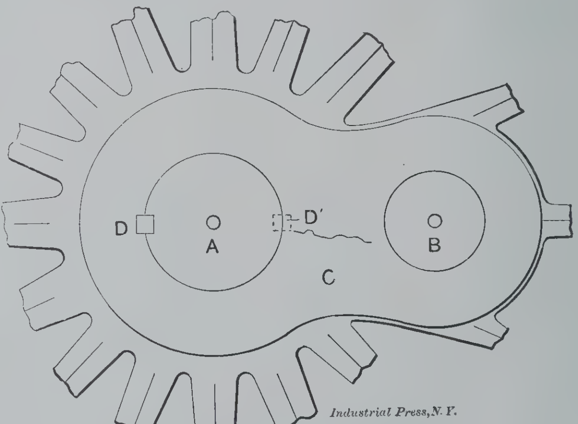


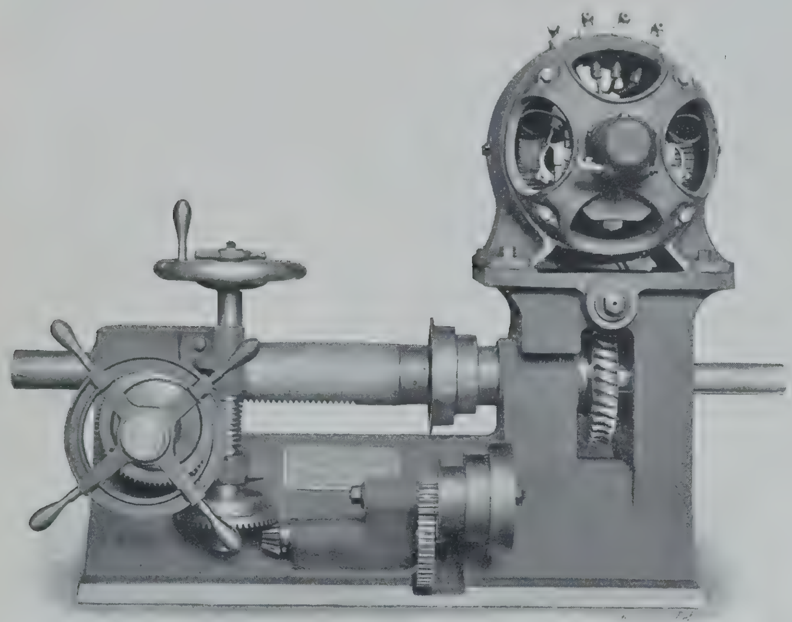
Fig. 2. Correct and Incorrect Location of Keyway.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

PORTABLE HORIZONTAL DRILLING MACHINE.

The accompanying illustration shows a new design of portable, horizontal drilling machine which is the outgrowth of the demand for portable tools to be used on a floorplate in accordance with modern shop methods. It can be used to advantage by engine builders, manufacturers of electrical machinery, etc. The machine shown is the smallest of several sizes which are adapted to meet the different requirements of the work to be handled.


Portable Horizontal Drilling Machine.

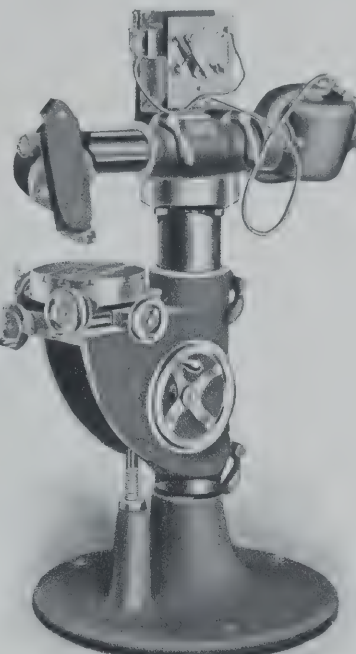
The machine is very powerful, being geared from the armature shaft to the worm shaft, and power being supplied to the spindle by means of a steep lead, phosphor bronze, worm wheel driven by a hardened steel worm. There are three changes of automatic feed, hand feed and quick return. The base is planed on the bottom edge, parallel with the spindle, for convenience in setting on the floorplate, or for parallel strips as required. These machines are made by The Newton Machine Tool Works, Philadelphia, Pa.

A UNIVERSAL SHAPER FOR PUNCH AND DIE WORK.

The shaper illustrated in the photograph herewith is built upon entirely new and original lines and is designed for all kinds of intricate punch and die work as well as for metal pattern and jig making. It justifies its claim as a universal machine by its ability to work at every possible angle. The tool cuts from the face of the work leaving no burr to cover the lines, making it possible to machine very accurately so that little if any hand work is required. The working head is carried upon a horizontal arm which is supported by the head of the column and this is graduated so that it may be clamped at any position about the column. This arm has also an in-and-out adjustment that allows the head to be brought to any position above the table.

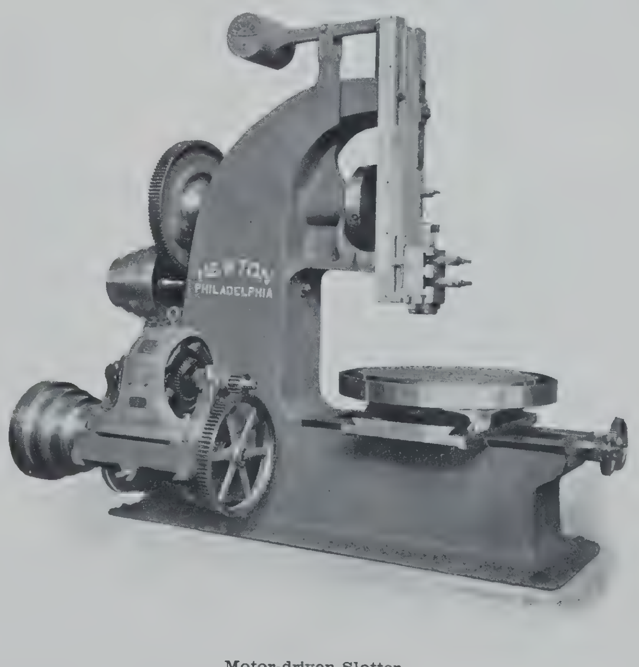
The head may be adjusted at any angle about its axis, which is at right angles to the arm, and as the arm in turn may be adjusted to any position about its own axis, it is therefore possible for the head to work at any angle desired. Graduations are provided for both of these adjustments. The ram is driven by a worm and wormwheel, direct connected to a motor that is mounted at the end of the arm, and the stroke of the ram is adjustable.

The table has circular and two cross movements, the handwheels by which it is operated being provided with dials for micrometer readings and the table itself being graduated. Provision is made for locking the circular movement in any position or for disengaging it so that the table may be swung around freely. The circular movement is obtained by means of a worm and wormwheel having the same ratio that is used in universal dividing heads and thus fitting it for accurately indexing dies for small gears, armature plates, etc. The machine is made by the Cochrane-Bly Machine Works, Rochester, N. Y.


Universal Punch and Die Shaper.

ELECTRICALLY-DRIVEN SLOTTERS.

The Newton Machine Tool Works, Philadelphia, Pa., have just brought out a new line of slotting machines, built from new designs, and arranged for electric motor drive. The illustration shows the 14-inch machine using the regular driving cone pulley as would be used with a belt-driven tool, with the motor mounted on a sliding bracket on the side of the machine, and gearing from the armature shaft to the cone shaft, which acts practically as a countershaft, giving the desired changes of speed.



Motor-driven Slotter.

The same machines are also arranged with a positive drive by gearing the armature shaft directly to the operating gears, the variation of speed being obtained through slip gears, the same as change gears on a lathe. The same design is also used, with the slip gears omitted, when variable speed motors are employed.

HEAVY DOUBLE-SPINDLE BORING MACHINE.

The large double-spindle boring machine shown in Fig. 1 was recently built by the Betts Machine Co., Wilmington, Del., and installed by the Philadelphia & Reading Coal and Iron Co. in their shops at Pottsville, Pa. While primarily intended for boring the cylinders of Corliss engines, machining the ports and cylinders simultaneously, it is a machine that can be advantageously used on a wide variety of heavy work for boring and milling. The work spindles are located at right angles, and are independently driven through geared variable-speed mechanisms by five horse power induction motors running at a constant speed of 710 revolutions per minute. The machine is practically two independent horizontal boring mills mounted at right angles and using a common floor plate. The main floor plate is a rectangular casting, 10 feet wide by 17 feet long. Bolted to one side and across one end are the castings supporting the heavy posts carrying the boring heads. These plates are 40 inches wide and about 20 feet 8 inches long, being extended so as to form the supports for the motors and reduction gearing. One end of the main floor plate is used for the outboard bearing of one boring bar, and an extension plate 34 inches wide and 14 feet 10 inches long is bolted to the side of the main bedplate opposite the other boring head to support its outboard bearing. With the outboard bearings or steady rests removed, an unobstructed floor plate nearly 13 feet wide and 17 feet long is available.

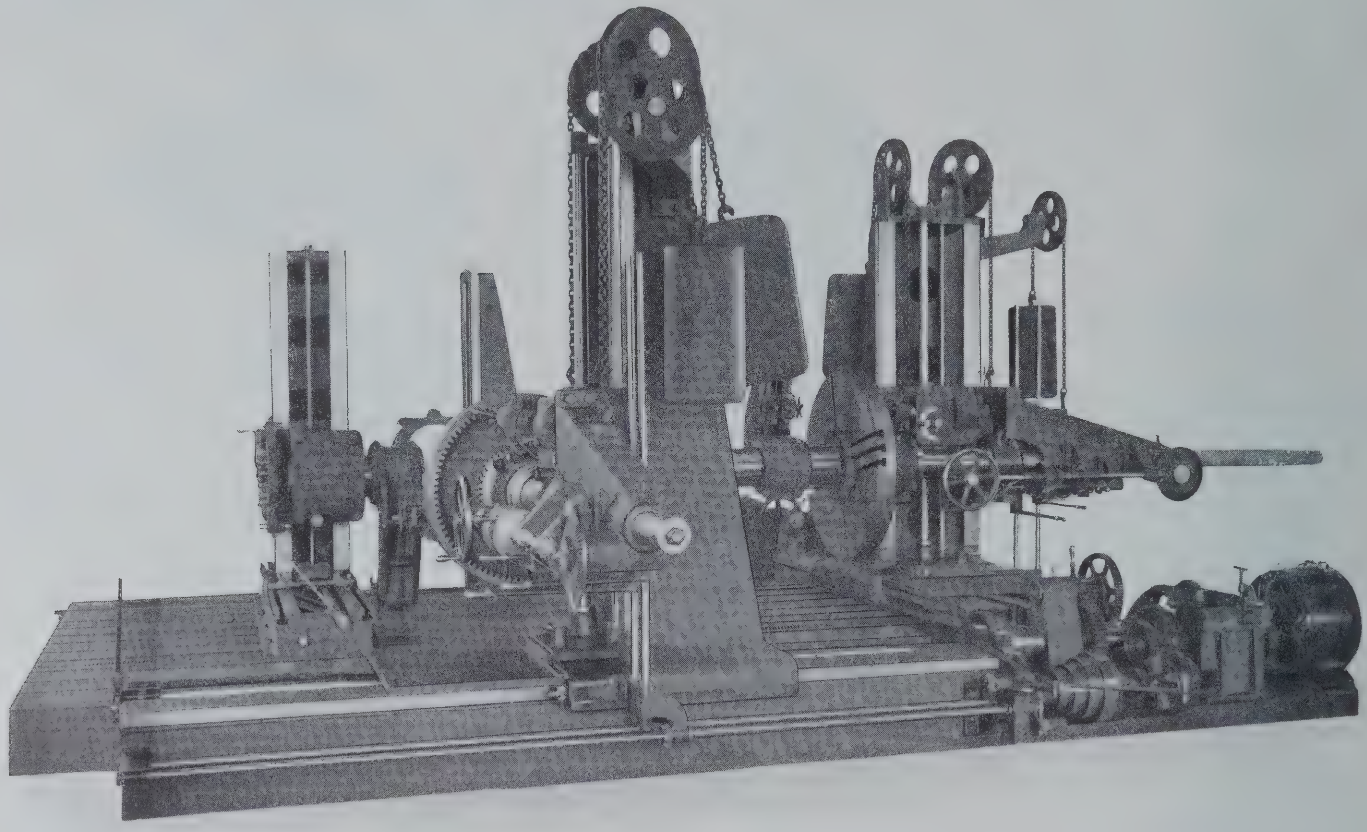


Fig. 1. Betts Double-spindle Boring Mill.

The work spindles are 4 15-16 inches diameter and have a traverse of 48 inches. When boring large cylinders a cast-iron bar 10 inches in diameter is used, which is bolted to the faceplates and supported at its outer end by the outboard bearing. The traversing boring head on the bar is operated by a star feed, and the two facing heads on the bar are fed in the same manner. The posts carrying the boring heads are traversed on the bedplate by screws, the traverse being 10 feet in each case. The vertical height of the posts is 7 feet 9¾ inches, and the vertical traverse is 54 inches. The speed and direction of vertical and horizontal traverse is controlled by the operator, through the medium of the handles shown be-

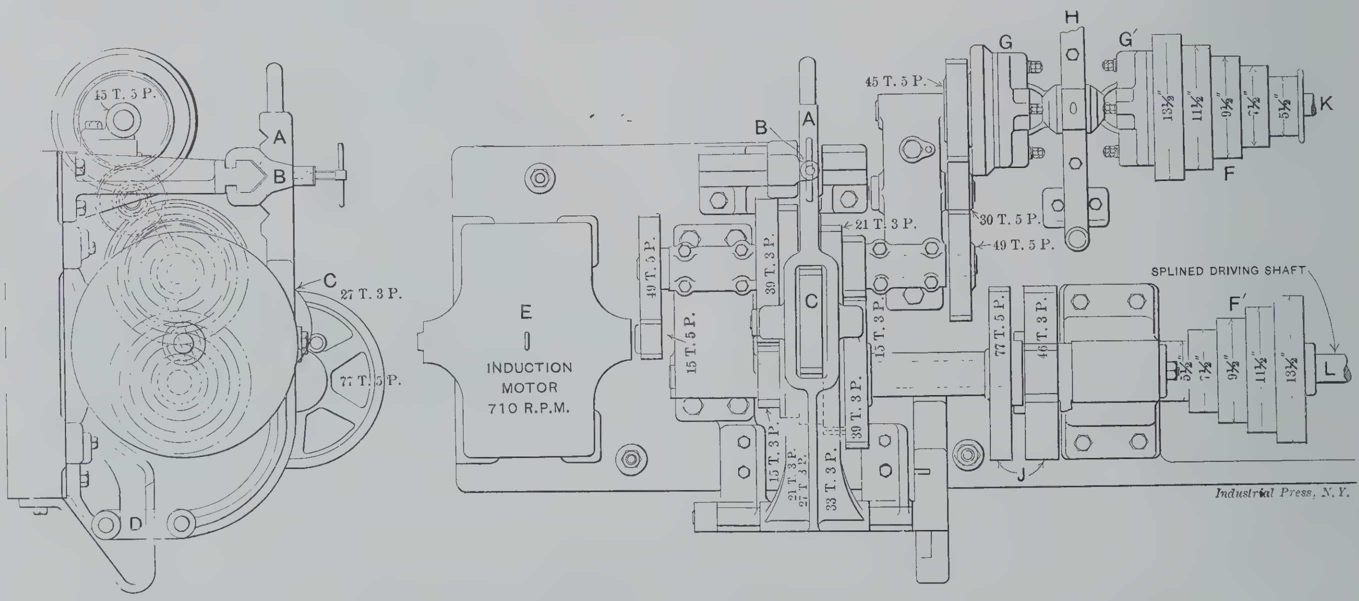


Fig. 2. Variable Speed Gear for Driving Double-spindle Boring Mill.

neath the boring head in the foreground; also at the right of Fig. 1.

The positive variable-speed gear is shown in Fig. 2. It consists of two cones of gears between which is the transmitting pinion C, mounted on the frame A. This frame may be moved longitudinally so as to bring the transmitting pinion C between any pair of gears in the two cones. The link D permits the frame to shift transversely so as to accommodate pinion C to the relative positions of the gears brought into engagement. Notches on the frame A engage the V-shaped top of the slide upon which it normally rests and a clamp is provided for locking it in place. The cones of gears in conjunction with the back gears J give ten changes of speed up to the boring head. Motion is transmitted to the work spindle by means of a pinion which may either engage the internally toothed faceplate or a smaller gear on its hub, thus multiplying the speed changes by two, so that spindle has twenty different speeds. The slow traverse of the saddles carrying the spindles horizontally and vertically, as necessary for milling operations, is taken from cone pulley F' by belt to cone pulley F with the clutch lever H, Fig. 2, at the right. The cone pulley F then drives the shaft on which it is mounted. For the fast traverse the clutch H is shifted to the left, engaging clutch G, which has the effect of driving the shaft K at one-third the rate of the motor, and, of course, giving a relatively rapid traverse. Tumbling gears are interposed between the shaft K and the traversing screw, so that the motion may be reversed. Reversal is effected by means of the horizontal and vertical splined shafts, and the levers beneath the boring head previously referred to. Split nuts are provided in the bases of the posts, so that engagement with the horizontal screw may be thrown out when vertical traverse is wanted. To throw out the vertical traverse the bevel gears transmitting motion to the vertical screws are disengaged. Since the direction of spindle rotation would be changed when shifting the driving pinion from the internally toothed faceplate to the external gear previously mentioned, it is necessary to provide means for again reversing the direction of rotation to prevent running backward. This is done by shifting a pair of bevel gears vertically on the vertical splined driving shaft, so that one disengages as the other engages. This is also used when tapping. The lever for doing this shows plainly in Fig. 1, on the right-hand boring head directly over the spindle and at the left of the feed handwheel.

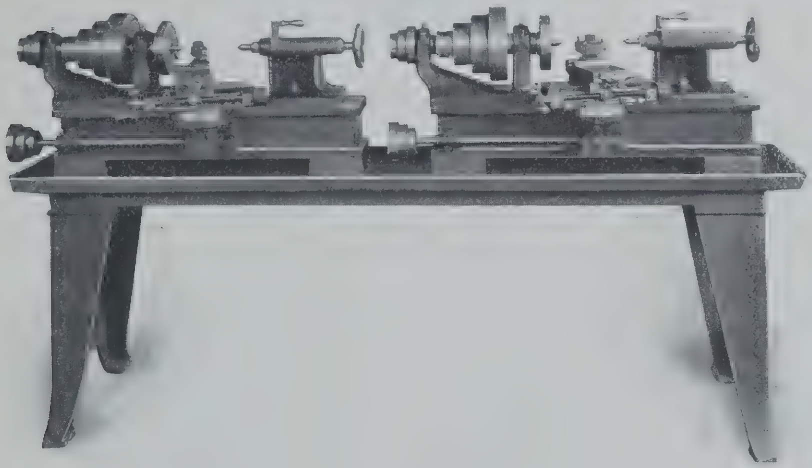


Fig. 1. Duplex Universal Turning Lathe.

It will be noticed that the boring heads are counterbalanced at three points, the object being to avoid all canting, twisting moments as much as possible. The weight of the machine complete is 105,000 pounds.

TWELVE-INCH UNIVERSAL TURNING LATHE.

The duplex lathe illustrated in the accompanying half-tone was designed for turning all kinds of work requiring accuracy and at the same time speed of production. It is built with two bodies mounted upon one rigid base which forms a pan for catching the chips and oil. The tool saddle is rigidly fastened to a lug that is cast on one side of the bed and may be swiveled to any angle required. Feed motion is transmitted from the feed rod, through gearing, to the slide rest which is provided with automatic feed in either direction irrespective of the position to which the slide may be turned. Adjustable feed stops are also provided. The gearing is all encased and protected from chips and dirt.

The tool holder furnished on these lathes, and shown in section in Fig. 2, is of new design and fitted for carrying a tool of self-hardening steel at each end. The lower bushing is threaded into the body of the holder so that by turning the bushing the holder may be raised or lowered to any desired height where it is locked by the nut on the top. By releasing this nut the tool may be used at either end. This lathe and tool holder are built by the Resek Machine Tool Co., Cleveland, Ohio.

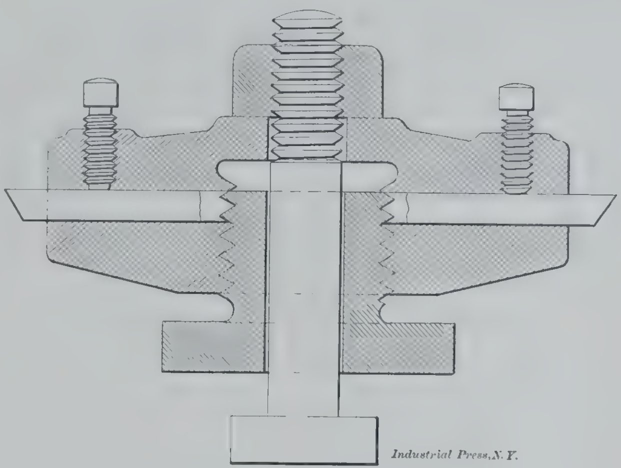
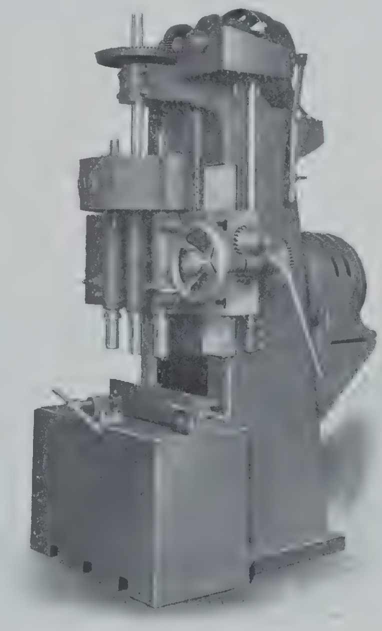


Fig. 2. Double Adjustable Tool Holder.

A THREE-SPINDLE RAILROAD FISH-PLATE DRILL.

The accompanying half-tone illustrates a three-spindle drill that is designed especially for drilling the ends of rails and for fish-plates. The machine has a capacity for drilling, simultaneously, three 1½-inch holes in steel. The spindles may be set to drill holes spaced at any center distance from 3¼ up to 9½ inches. The two outer spindles have a vertical adjustment, by rack and pinion, of 3½ inches and can be clamped in any position required. The spindles are bored out for No. 4 Morse taper and, on account of the spindle adjustment, taper shank drills can be used, thus doing away with the objectionable method of using setscrews for the adjustment of straight shank drills.


Rail and Fish Plate Drill.

The three spindles are carried on one saddle, which is counterbalanced and feeds the three simultaneously. The center spindle is driven by a large bevel gear on top of the column, and this in turn drives the two outer spindles by our gearing, through intermediate gears that are pivoted to oth the central and outer spindles and move in and out with he horizontal movement of the spindles. The saddle carrying he spindles has three changes of power feed and quick re- urn. The feed is driven by cones of gears and changes in eed are quickly made by a lever on the side of the column. he work table is provided with an adjustable vise for hold- g the rails and both right and left hand stops for the end the rail can be used.

The cuttings drop through an opening in the top of the ble and thence, through another opening in the back of he column, out of the way of the operator. There is also an pening, 10 inches square, through the back of the column on level with the top of the table, allowing work to be put hrough the column, to be operated upon. The photograph hows the machine arranged for motor-drive, but it is also urnished for belt driving by the builders, the Mark Flather laner Co., Nashua, N. H.

GLEASON IMPROVED CUTTER GRINDER.

The F. Gleason Machine Works, Olney, Pa., have brought ut an improved form of cutter grinder which is illustrated erewith. In this machine the spindle carrying the wheel is o mounted that it can be swung from the vertical position, n which it is shown, through any angle down to the hori- ontal. This brings the wheel within range of a great variety f work and allows wheels of different shapes to be used. he spindle has a movement, through a quill and handwheel, f 3 inches, the hub of the handwheel being graduated to .002 nch. The head in which the spindle is carried has a hori- ontal adjustment of 3 inches and may be locked, by means of lever, in any position.

The pawl guide by which the teeth are fed around, can be hanged from a level to an angular position and may also be aised or lowered in its socket to suit the requirements of he cutter. For instance, in grinding a spiral cutter any ooth which is most convenient can be acted upon by the pawl s it can be fed from either side as well as from the top. utters, up to 3 inches in diameter are held by friction be- ween the centers but for the larger sizes a carrier is used in he faceplate *F* which is attached to a sleeve that passes hrough the split collar *G* and is locked by the setscrew *H*. This lock is always employed when grinding large cutters ith the exception of spirals.

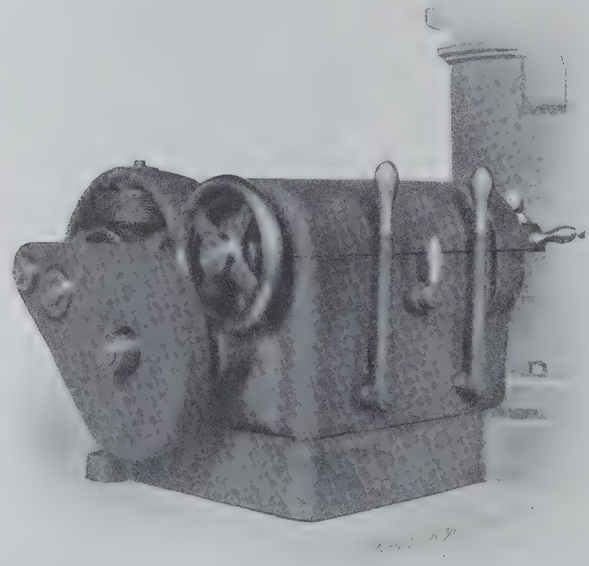
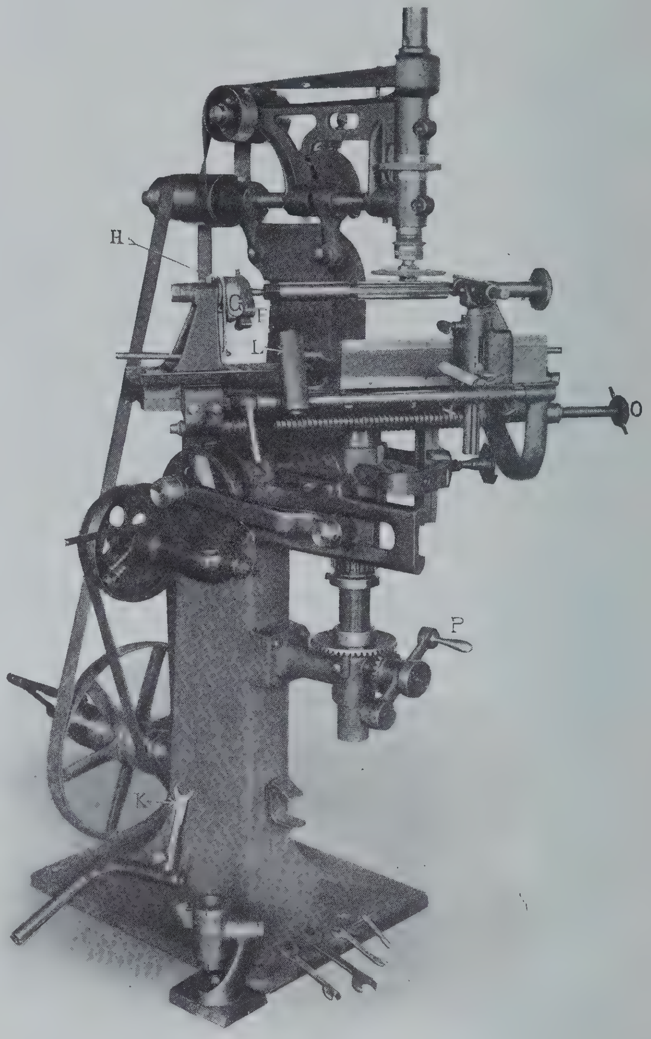


Fig. 1. Speed Box used on Mueller Radial Drill.

When grinding spirals the fork *K* is placed in the socket *L*, the prongs being placed in the spirals of the cutter. A spring shown wound around the collar *G*, holds the cutter blade up to the fork and, as the fork is stationary while the cutter travels, spiral motion is imparted to the cutter. The emery wheel works between the prongs of the fork, which does not leave the cutter during the process of grinding, one prong always remaining on to keep the cutter in place when the pawl feeds from one tooth to another. The angle of the bed with the spindle can be changed from 0 to 90 degrees and clamped fast wherever desired. The relative position of the cutter to the wheel can be changed by the screw rack *O* while the machine is in operation. This screw can also be used as a hand feed if necessary. The crank *P* is used for bringing the cutter up to the wheel and its hub is graduated in thousandths of an inch.



Automatic Cutter Grinder.

SPEED CHANGING DEVICE FOR RADIAL DRILLS.

The half-tone, Fig. 1, shows a new speed box, driven by a constant speed motor, that has just been brought out by the Mueller Machine Tool Co., Cincinnati, Ohio, and applied by them to their radial drills. The two long levers, shown in front of the box, operate four friction clutches, giving instantly the same four speeds as the usual step cones. The numbers cast on the lid of the box indicate in what position the levers should be brought for the different speeds. The small handle locks one lever while the other is in use.

The two levers, shown at *R* on the next page, Fig. 2, are used to engage the friction clutches *T*, by means of the forks *S*, with either of the gears *E*, *F*, *G* or *H*, on the motor-driven shaft *A*, and they mesh with gears *I*, *J*, *K*, *L* on the shaft *B*. Gears *K* and *L* also mesh into *N*, *P*, *Q*, *M*, giving power to shaft *C* which, through miter gears, drives the eccentric shaft *D* in the column. When reverse motion for tapping, etc., is required, the gear *O*, which is on a tumbler, is engaged with gear *L*, making gear *M* run in the opposite direction.

All starting or stopping of the machine is controlled by a loose ring encircling the column which, when moving the bar *X*, causes sleeve *W* to turn in its bearings and move the rack *Y*, and the rod *V* with the fork attached to its end, back and forth. This engages either of the friction gears *M* or *N* to the shaft *C*, and in changing from *M* to *N* double the speeds derived from the shaft *A* are delivered to the shaft *C*, and by using the back gears that are provided, the usual sixteen speeds are obtained on the work spindle. This speed box is also made to be driven by plain pulleys instead of a motor when desired.

STEEL MITER BOX.

The cut illustrates a new miter box that has just been placed on the market by the Goodell Manufacturing Co., Greenfield, Mass., and which is especially suited for pattern shop use. Being made entirely of steel it is calculated to last for a long time and its accuracy is insured. The back is formed in corrugations, ¼ inch deep by ½ inch wide, allowing perfect clearance for sawdust. Besides the angles usually provided for, by simply turning a lever this box can be set at any angle desired. The box is made in two sizes, either of which can be furnished with extra angle attachment to increase the angle above 45 degrees.

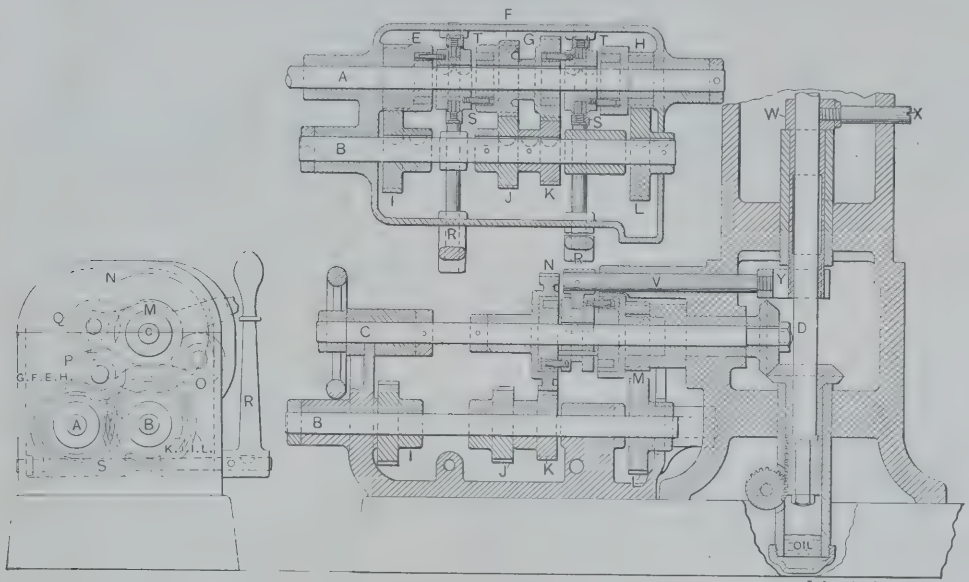
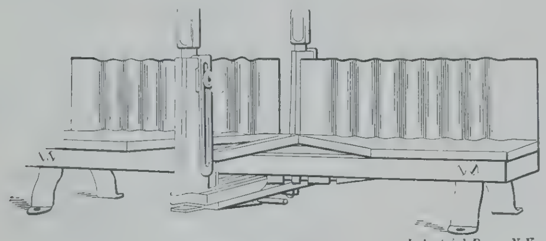


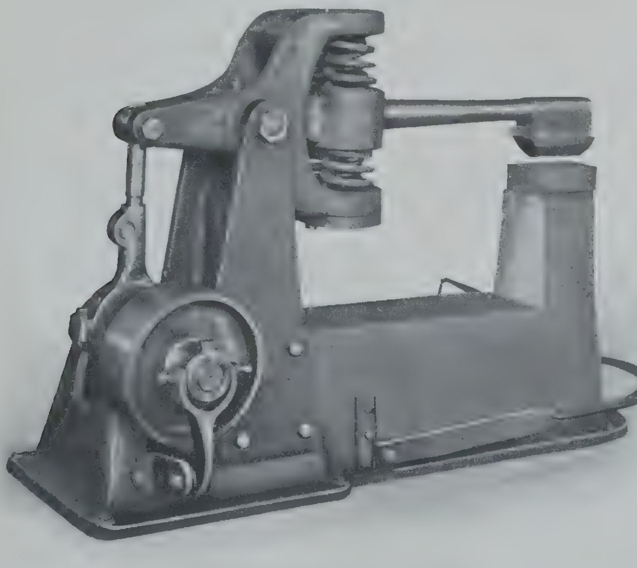
Fig. 2. Detail of Mueller Speed Changing Device.



Steel Miter Box.

THE "DAYTON" POWER HAMMER.

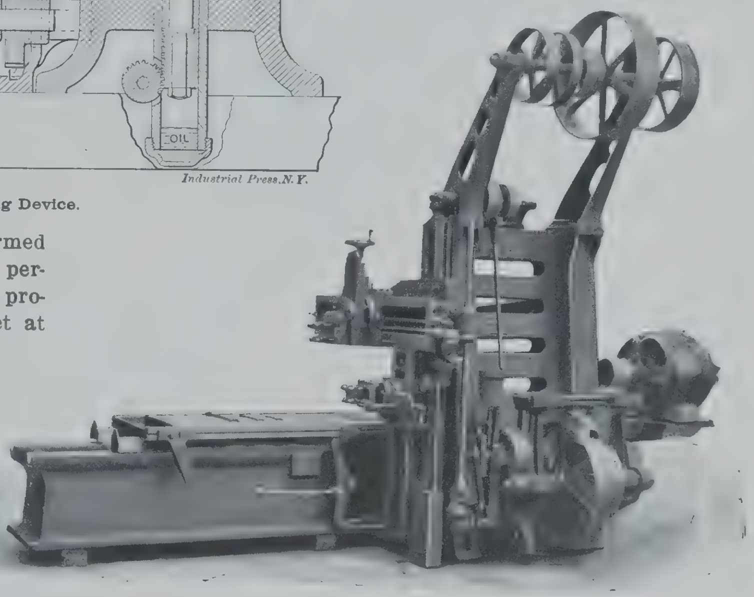
The cut illustrates the "Dayton" power hammer in the form in which it has lately been constructed with a view to fitting it for the use of blacksmiths and wagon makers, and in the larger manufacturing concerns where the smaller size has proved well suited to the requirements of the tool dresser. With the aid of this hammer it has been found economical to work up old scrap, such as horseshoes, etc., into bar stock for use in the shop. These hammers are now being made by the Miami Valley Machine Tool Co., Dayton, Ohio, in two sizes, weighing 900 and 1,500 pounds, respectively. Both sizes have a stroke of eight inches. The helve-head of the No. 1 hammer measures 2 x 4⅝ inches, and that of the No. 2 is 3¾ x 8 inches. Both sizes are belt driven and are operated in the usual manner by means of a foot lever.



The "Dayton" Power Hammer.

36-INCH MOTOR-DRIVEN OPEN-SIDE PLANER.

The Detrick & Harvey Machine Co., Baltimore, Md., have lately adopted the application of electric drive for their open-side planers, the method by which this is accomplished being shown in the accompanying photograph, which is an illustration of their 36-inch motor-driven planer. Upon the top of the post is placed a countershaft from which the planer is driven in the usual manner. This countershaft, in turn, is driven from the motor which is carried on a bracket at the back of the post. The countershaft is usually furnished with a flywheel or heavy rimmed pulley of sufficient weight to reverse the platen without causing excessive fluctuations of load upon the motor.



Motor-driven Open-side Planer.

A SPIRAL GEARED HANGER.

To obviate the troubles incidental to the use of a quarter turn belt for driving shafting at right angles, the Diamond Clamp & Flask Co., Richmond, Ind., are placing on the market the spiral geared hanger shown in Fig. 1 on next page. Fig. 2 shows a section through the spiral gears by which the power is transmitted. They are machine molded so as to insure easy and quiet running. As will be seen in the cut, the thrust of the gears is taken on ball thrust bearings, thus reducing the friction to a minimum. The casing not only efficiently encloses the gears but it is cored to form an ample oil pocket having return channels to insure a proper circulation of the oil. This design of hanger besides affording a means for transmitting power at right angles combines with it an adequate support for both of the shafts. These hangers are also built for transmitting from vertical to horizontal shafts at right angles, and they are also furnished with tight and loose pulley, thus fitting them for application to countershafts.

ANGLETTES FOR THE DRAFTSMAN.

The "anglettes" shown on next page are designed for use in lieu of a protractor in drawing angles, and will be found of great convenience in the drafting room. They are made of celluloid and thereby possess all of the advantages of the transparent triangles. The set consists of ten pieces, each four inches in length, having the upper edge accurately cut to make an angle with the base. The angles range from 1 degree to 10 degrees inclusive and the set may be augmented if desired, by the addition of ½ and ¼ degree pieces. The degree of each anglette is plainly stamped upon its surface, and since they are solid there is no possibility for the angle to change. Used in conjunction with a 30-degree triangle, it is possible to obtain any degree without using more than two anglettes at a time in the combination. Some illustrations of how the pieces are used are shown in Fig. 2. Each set is neatly packed in a substantial box. They are being placed on the market by Jas. Dangerfield, Hartford, Conn.

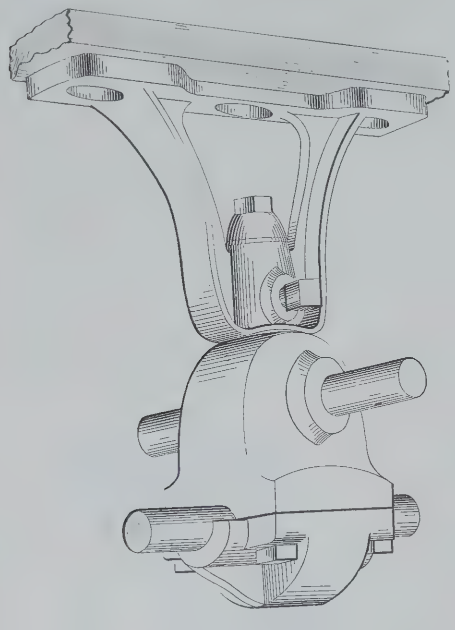
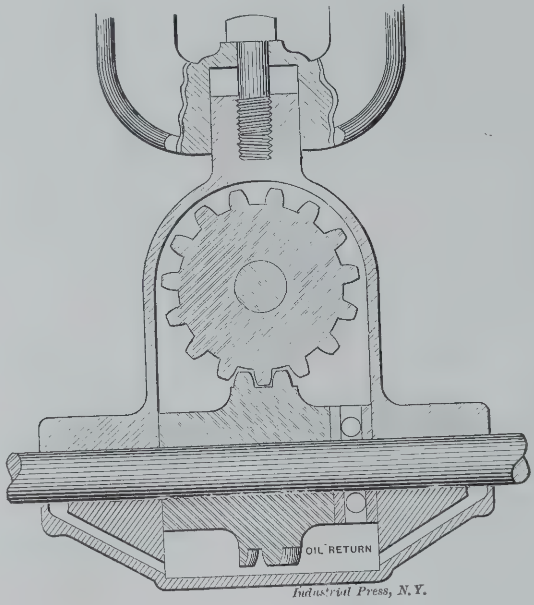


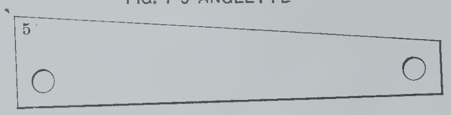
Fig. 1. Spiral-geared Hanger

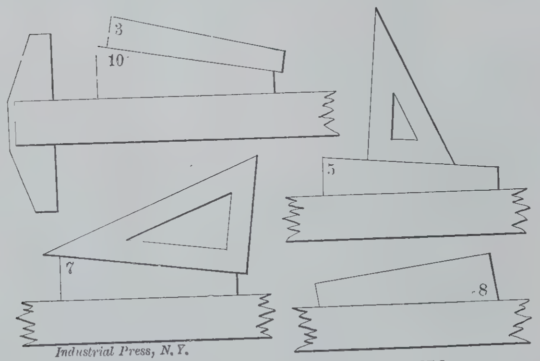


Industrial Press, N.Y.

Fig. 2. Section through Hanger.

FIG. 1-5° ANGLETTE





Industrial Press, N.Y.

FIG. 2-METHOD OF USING ANGLETTES

* * *

Just at the present time the "anti-wireless" partisans seem to be having the best of the battle that has so far been chiefly waged on paper. The wireless service instituted by the Marconi Co. to the London *Times* has suddenly been discontinued without explanation beyond that some part of the apparatus had broken down, but of course this explanation is lame and impotent. The claim of the Marconi Co. that they have a system of "tuning" by which signals being transmitted to any other selected station cannot be interfered with or intercepted by rival stations, received a severe setback a few days ago. Dr. Fleming, who is connected with the company, was demonstrating the receipt of a message from Cornwall to London when the word "rats" interpolated itself in the message much to the professor's disgust and to the delight of his opponents. The professor denounced the action as a piece of "scientific Hooliganism" and called for the perpetrator to reveal himself. Mr. Nevil Maskelyne at once announced himself as the "villian" in a letter to the *Times*, and chuckled over his success in having proven that the claims of the Marconi Co. as to their infallible selective system, were scarcely based on fact. Mr. Maskelyne also stated that a message received from Poldhu by the Royal Institution in the afternoon had been practiced from 11 o'clock in the morning and that fifty horse power were required in sending it. Meanwhile the public anxiously awaits the advent of the wireless telegraph and telephone.

* * *

A United States consular report from Coburg, Germany, describes an interesting product made from milk casein which is called "galalith" or "milk stone." This product is used as a substitute for horn and celluloid in the manufacture of combs, knife handles, balls, chess figures, dominoes, ferrules, slabs in imitation of marble, etc. An advantage that the new product has over celluloid is that it does not ignite readily and has no odor. It is largely impervious to water, being about on a par with horn in this respect. It is expected that it will be a valuable addition to the electrical industries as an insulating material.

* * *

NEW TRADE LITERATURE.

The New Era Iron Works Co., Dayton, O. Illustrated catalogue of the New Era gas engines, full particulars of which are here given. These are built in sizes from 5 horse power to 125 horse power.

The Garvin Machine Co., Spring and Varick Streets, New York. Booklet calling attention to the very complete stock of machine tools carried. These include drills, shapers, lathes, boring mills, etc.

The Roe Stephens Mfg. Co., Detroit, Mich. Catalogue and price list No. 9 of valves in brass and iron. This is very complete, 103 pages being devoted to valves of every description, all of the company's own manufacture. A telegraph code is given in the back.

The Fairbanks Machine Tool Co., Springfield, O. 1903 catalogue and price list of lathe, planer and shaper tools. The Fairbanks universal swinging cut-off tool, planer tool, threading tool, adjustable boring tool attachment, and various side tools, etc., are described and illustrated herein.

The National Brazing Co., Dayton, O. Booklet calling attention to the "Eureka" brazing compound for the repairing of broken cast-iron castings. The company here state that it does not require an expert to use "Eureka," but that any brazier, machinist or toolmaker can use it.

Wyman & Gordon, Worcester, Mass. "A short story of Eli Whitney," being an interesting sketch of this great mechanic and inventor. Whitney introduced the system of interchangeable parts, which has made possible the production of any and all machinery in large quantities, with great speed and the highest precision.

The Goheen Mfg. Co., Canton, O. Catalogue of the company's protective paint, called "carbonizing coating," which shows examples of this coating as applied to roofs, water pipes, blast furnace cupolas, trestles, gas tanks, bridges, etc., in fact, wherever iron and steel are used.

The Goddard Machine Co., Holyoke, Mass. Illustrated catalogue of grinding and polishing machines. These are of various sizes and styles. A combination knife grinder, tool grinder and saw gummer is shown for use in shops where a variety of work is required of such a machine.

The American Spiral Pipe Works, Chicago, Ill. Catalogue and price list of spiral riveted pipe for water lines, exhaust steam work, etc. This is manufactured in sizes from 3 to 40 inches in diameter. Much information is given concerning this product and twelve pages of valuable tables and other data also appear.

The John M. Rogers Boat, Gauge & Drill Works, Gloucester City, N. J. Catalogue "E" of rock drills for work in quarrying, shaft-sinking and tunnel driving. These drills are operated either by steam or compressed air. A number of cuts show the drills and their details. The "Eureka" valve and steam chest is a feature of this drill to which they would like to call special attention.

The Hoggson & Pettis Mfg. Co., New Haven, Conn., Leaflet calling attention to the company's latest catalogue, which treats of chucks. They request customers to state on their next order how many desks they have that are not provided with pin cushions, which useful adjunct (a sample of which we have received) we take it they will supply.

The General Pneumatic Tool Co., Montour Falls, N. Y. Bulletins Nos. 53 and 54. No. 53 treats of the company's column riveting machine for riveting of columns and general riveting. No. 54, of their combined stationary and portable pneumatic riveter which is adapted to shops where the amount of riveting done will not warrant a stationary and a portable riveter.

The Pike Mfg. Co., Pike Station, N. H. Illustrated catalogue of scythe stones, oilstones, grindstones, axe stones, etc. These are shown in a large variety and for many purposes. The company has been established since 1823, and their factories and quarries are at Pike

Brown & Sharpe Mfg. Co.

Providence, R. I., U. S. A.

Mechanical Machinists' Tools

that are

Noted for their Accuracy

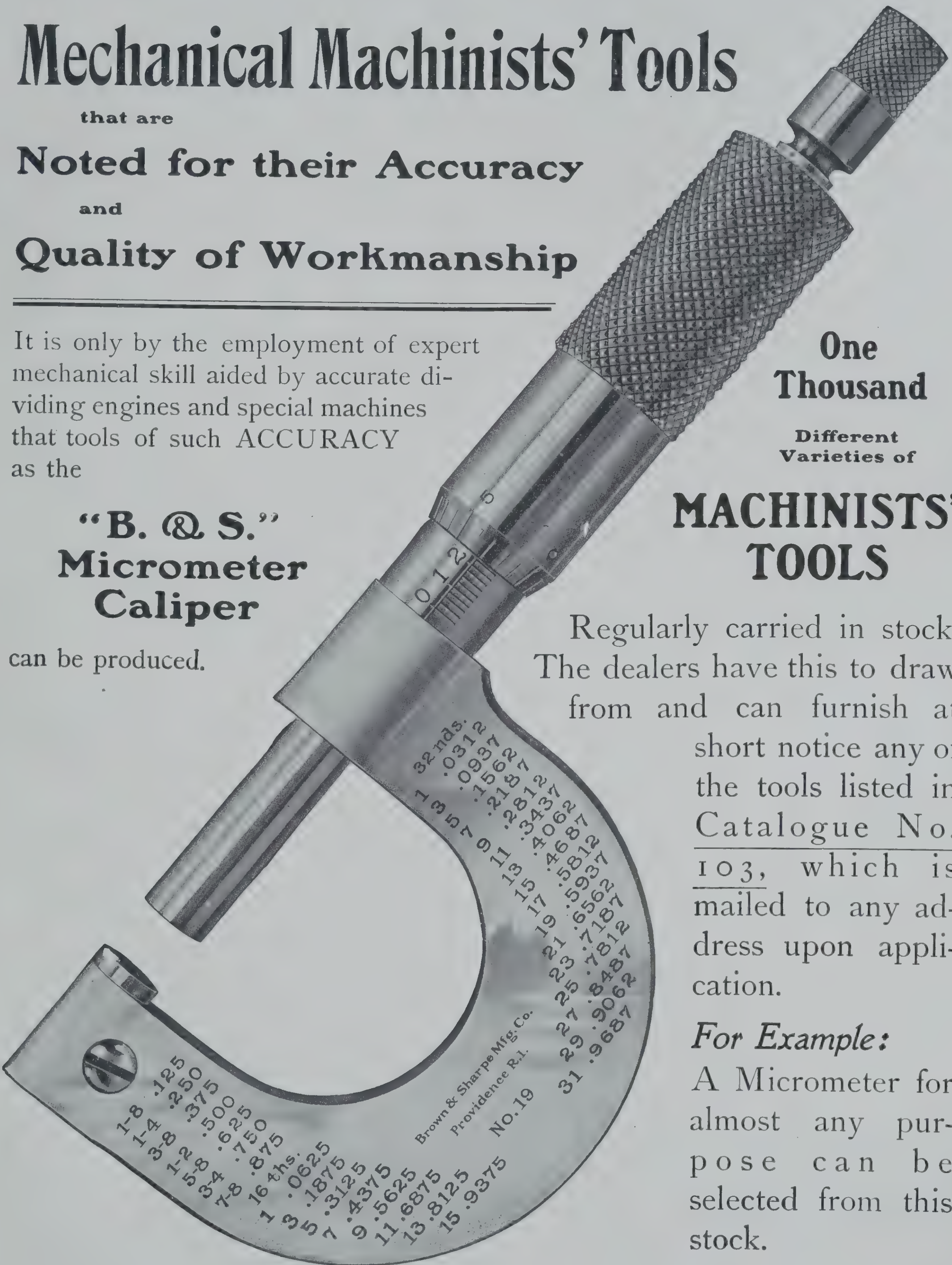
and

Quality of Workmanship

It is only by the employment of expert mechanical skill aided by accurate dividing engines and special machines that tools of such ACCURACY as the

"B. & S." Micrometer Caliper

can be produced.



One Thousand

Different Varieties of

MACHINISTS' TOOLS

Regularly carried in stock. The dealers have this to draw from and can furnish at short notice any of the tools listed in Catalogue No. 103, which is mailed to any address upon application.

For Example:

A Micrometer for almost any purpose can be selected from this stock.

100 Different Styles of Micrometers Carried in Stock.
Other Lines of Machinists' Tools Equally Complete.

Station, N. H.: Lisbon, Piermont, and Littleton, N. H.; Evansville, Vt., Manlius, N. Y.; Hot Springs, Ark.; and Orleans, Ind. The New York office is at 151 Chambers Street.

The Standard Roller Bearing Co., Forty-eighth and Girard Avenue, Philadelphia, Pa. Catalogue of ball and roller bearings. This illustrates the roller, ball, roller thrust, grooved ball, and propeller roller thrust bearings; also railroad bearings. A long list is given of the large number and variety of machines to which these bearings can be profitably applied. The book is cloth bound, of convenient size, and should prove useful to any one interested.

The C. W. Hunt Co., West New Brighton, Staten Island, N. Y. Catalogue 035, of coal handling machinery. This facilitates the rapid and economical transportation of coal and ashes to their destination. Industrial railways, electric locomotives, steam and electric hoists, coal tubs and chutes, steam shovels, wheelbarrows, coal crackers, hoppers, etc., and hoisting blocks and wire and manila rope for hoisting purposes are here shown.

The Sawyer Tool Mfg. Co., Fitchburg, Mass. Illustrated catalogue "F" of fine tools and hardware specialties. This includes various sizes of center gages, straightedges, protractors, combination squares and in fact all the small tools so well known and much employed by the mechanic. The company call attention to the accuracy of these tools and state that *all* their squares are furnished with hardened blades.

The Cochrane-Bly Machine Works, Rochester, N. Y. Pamphlet describing the Cochrane-Bly universal shaper, which has been designed to cover a great variety of work and is adapted to all classes of intricate punch and die work, metal pattern and jig making. The company state that with this machine work may be planed at every possible angle. A half-tone cut of this shaper is shown and also several examples of the work done.

The Foos Gas Engine Co., Springfield, O. Catalogue No. 12 of gas and gasoline engines. This is 8 x 10½ inches, and full page cuts are given which certainly show the engines to advantage. The Foos "Special" engine appears, for operating on gasoline, naphtha, distillate, etc.; also a portable engine with steel truck; one with wood truck, the Foos traction engine, and an electric engine. The Foos electric igniter, governor, bed casting and crankshaft, inlet and exhaust valves, connecting rods and cams are described in detail.

The Garry Iron & Steel Co., Cleveland, O. Catalogue of pneumatic, electric and hand power cranes. These are built for a great variety of purposes, such as unloading freight or passenger car trucks, loading and piling buffer beams, loading and piling material in factories and store rooms, coaling locomotives, etc. A portable pneumatic plant is also shown, used in contracting work, consisting of a boiler, steam-driven air compressor, air receiver, coal tank, water tank, and arranged on a steel truck to be drawn by horses wherever needed.

The Joseph Dixon Crucible Co., Jersey City, N. J. Booklet descriptive of Dixon's latest product, the "Eterno" indelible pencil. This writes such a dark purple as to be practically black, and the copy is clear, sharp and indelible. It may be put to many and various uses and combines the convenience of the pencil with the permanence of the pen. A clever little sketch shows some unfortunate specimens of humanity wearily struggling along under the burden of "The Pen" with its uncomfortably dripping load of ink; and another pictures a duel, with swords, between the "Eterno" and "The Pen," in which, of course, the former comes off victorious. We sincerely hope the Recording Angel will not hear of Dixon's "Eterno" *indelible* pencil.

The Ingersoll Milling Machine Co., Rockford, Ill. Illustrated catalogue, April, 1903, of heavy milling machines. This is a handsome work of large size, with excellent half-tone engravings of the company's product, which is milling machines exclusively. Following are some of the varieties built: Four-head milling machine, spur driven, and worm-driven; three-head worm-driven milling machine; combined horizontal and vertical milling machine with universal head on rail; single and double vertical milling machine of many sizes; horizontal millers, some plain, some with vertical spindle attachment—in fact, every variety and size that can be required for milling work. A number of page cuts illustrate different examples of intricate milling accomplished by the use of these milling machines.

The Cleveland Pneumatic Tool Co., Cleveland, O. Catalogue E of pneumatic tools. This is handsomely gotten up, is printed on heavy coated paper and contains a large number of fine half-tone engravings. A number of new tools are listed, for chipping, calking, beading, riveting, in addition to the line of tools formerly manufactured. Interesting views show the various tools at work, among them a pneumatic painting machine and a special riveting hammer which is built by this concern to drive drift bolts in crib, dock and marine work. The various sizes and styles of these tools are given and short directions as to the proper care of each tool. Their line of pneumatic riveters is very complete, these tools being made to drive from ⅛ cold to 1½-inch hot rivets.

Schumacher & Boye, Cincinnati, O. Circular descriptive of their new 18-inch engine lathe. We believe there is no handsomer trade literature than that sent out by Schumacher & Boye, and this circular is a fine example. It is printed on heavy coated paper, and an excellent half-tone of the lathe illustrates the new patented instantaneous change gear device for feeds and screw cutting, a special feature of this new machine. A description of the lathe and specifications are also given. The company will continue the manufacture of their well-known line of standard engine lathes without the instantaneous change gear device. Their new office and warehouse building at Spring Grove Avenue, near their present works, is nearly completed, and they expect that it will be ready for occupancy about the first of September. The building will include a spacious and elegant club room, which will be used by the manufacturers whose works are in their vicinity.

The National-Acme Mfg. Co., Cleveland, O. Handsomely illustrated catalogue describing the "Acme" multiple spindle full automatic screw machines, and the semi-automatic screw slotting machines. The title page which is headed "The Spirit of Progress" shows by a series of pictures the evolution of the multiple spindle automatic screw machine. This is followed by a full description of the machine and of its leading features. The chief characteristic of this machine is that all tools act simultaneously, making it practicable to finish a piece with but one set of tools in use, in about the time required for a single operation. The various types and sizes of these machines are shown. A good part of the catalogue is devoted to the illustration of the various tools used on the "Acme" automatic and to fine examples of the work turned out. Typographically, the work presents an exceptionally fine appearance.

MANUFACTURERS' NOTES.

The Bradford Machine Tool Co., Cincinnati, O., manufacturers of engine lathes, are building a two-story addition to their shop, 60 x 100.

The Keystone Drop Forge Works, formerly located at Philadelphia, have removed to their new works at Chester, Pa., where they have increased facilities.

F. H. Bultman & Co., manufacturers of automatic gear cutters, have removed from their former location on 106-108 Canal Street, to more spacious quarters at 35 West Center Street, and 131 Viaduct, Cleveland, O.

The Milwaukee Rice Machinery Co., Milwaukee, Wis., report business as having been very good for the past year, and state there is every indication of its continuing so when the quiet period during the hot weather is past.

The Glacier Metal Co., New York and London, have established a southern office in Richmond, Va. Their New York office is at 26 Cortlandt Street. They manufacture the "Glacier" anti-friction metal used for high-speed and heavy running machinery.

Horsburgh & Scott, manufacturers of cut gears, Cleveland, O., have incorporated their business under the style of the Horsburgh & Scott Co., and have moved to their new works, 1240 Hamilton Street, that city, where they have additional room for their increased business.

The Columbia Engineering Works, Inc., William and Imlay Streets, Brooklyn, N. Y., have taken up the manufacture of the Arthur Herschmann patent steam wagons, and will build 3-ton and 6-ton capacity trucks. An automobile department has been established, equipped with tools specially adapted for the work.

E. & T. Fairbanks & Co., St. Johnsbury, Vt., recently decided to adopt a nine-hour day in their scale factory, which took effect on June 1. Since the establishment of this factory 60 years ago, we are told there has never been any strike or labor contest and this last concession was voluntary.

The Cincinnati Machine Tool Co., manufacturers of upright drills, are working on the plans for their new shop on the corner of Spring Grove Avenue and Township Street, Cincinnati, near Lodge & Shipley Co.'s. The building will be of brick, three stories high, 60 x 185, with light on three streets, and they expect to get in some time in October.

The Bates Forging Co., 410 No. Penn Avenue, Indianapolis, Ind., is a new company organized recently for the manufacture of a drop-forged double flanged wheel. They expect to be in full operation in the early fall, and are busy at the present time equipping their plant with all the necessary new tools. The president of the new company is F. L. Bates, formerly with the Indianapolis Drop Forging Co.; and the secretary and treasurer, John A. Glass.

The Diamond Drill & Machine Co., Birdsboro, Pa., inform us that their iron foundry and new steel plant continue to run night and day and that they are shipping castings in from one to four weeks. Despite their present facilities for turning out work, their modern methods and equipment, they find it necessary to build another open-hearth furnace to accommodate the large and increasing business. Their machine shop also shares in the general prosperity.

The Reeves Pulley Company, Columbus, Ind., report two splendid new sales agencies for their well-known "Reeves" wood split pulley—the Niles-Bement-Pond Co., Boston, for the New England territory; and the newly organized American Frog & Mfg. Co., Kansas City, Mo., for Kansas City and tributary territory. For both of these points large and well assorted stocks are now in transit, and the Reeves Company state that both enter the line with every evidence of a large pulley trade.

The Cincinnati Electric Motor Co., Cincinnati, O., will be known in future as the Barriett Electric Co. The officers are S. L. Barriett, president and treasurer; E. E. Prothereo, secretary. The new concern will manufacture stationary motors of from ½ horse power to 10 horse power, and are equipped throughout with automatic machinery. Mr. Barriett is well-known in the machinery field, having been master mechanic of the West Point Foundry during the Spanish-American war. He designed special tools and machinery for manufacturing projectiles, also several disappearing gun carriages.

The Derry-Collard Co., 256 Broadway, New York, inform us that of the first thousand copies of the "American Steel Worker," by E. R. Markham, less than 50 copies remain. We have at hand a booklet issued by this company calling attention to their list of technical books and their method of selling same, which is to send the work for examination, and if it does not prove to be what is desired, it may be returned to the company. Those interested in new technical publications, and in revised editions of old works, should secure one of these booklets.

The Lunkenheimer Co., Cincinnati, O., on July 18, tendered to their employees the annual outing (the forty-first) at Woodsdale Island Park. Seven hundred employees participated this year, with their families, making in all about 2,000 people, including the children. There were music, dancing and refreshments, cost of which was defrayed by the company, as also was the expense of transportation. The trip to Woodsdale Island Park is made on the C., H. & D. R. R., and it required two sections of ten coaches each to carry the passengers.

W. N. Durant, 231 Twenty-second Street, Milwaukee, Wis., has sent us a celluloid letter opener, always a useful article around a busy man's desk, on which appear a reproduction of the counters he manufactures and his name and business address. In addition to the usual purposes for which these counters have been used in the past, we are informed that Mr. Durant has perfected a method for using them in connection with power presses, thus forming a ready means of keeping account of the work produced without the necessity of manual counting. Since counters suited to this purpose have been placed upon the market they have been adopted by many of the leading builders of power presses as regular attachments to their machines and are reported to be giving much satisfaction.

The Gisholt Machine Co., Madison, Wis., have recently amended their articles of incorporation, increasing their capital to $750,000. Up to the present time the Gisholt Company confined themselves almost exclusively to the manufacture of the now well-known "Gisholt" lathe. These tools are made in several varieties and sizes, and the line is being constantly extended. The increasing business in "Gisholt" lathes has necessitated a very considerable increase in the manufacturing facilities of the company, and additions have recently been made, both in buildings and equipment, that will double the former capacity of the plant. While the new buildings and equipment will be largely used for producing "Gisholt" lathes, they will, in part, be used for the manufacture of other types of machine tools, such as boring mills, etc. The last-named machines, however, will not be manufactured on a large scale until new buildings now in contemplation are completed. Contracts have recently been made for a large new foundry to be equipped throughout with modern, up-to-date appliances. The building will be strictly fireproof.

The American School of Correspondence, Chicago, Ill., was recently tendered a series of receptions by the management of the Armour Institute of Technology, at which Dr. Gunsaulus, president of Armour Institute presided and Mr. William E. Curtis was one of the speakers. We have before us clippings from four leading papers giving interesting accounts of this event, and Mr. Zapf, the secretary of the school, reports that the school is in a most flourishing condition, as thoughtful people are beginning to recognize that correspondence instruction is filling a real need, bringing an education within the reach of thousands whose limited means and time would not allow them to follow a regular college course. All the officers and instructors of the school are college men, graduates from such institutions as the Massachusetts Institute of Technology, Harvard, Tufts College, etc., men fitted by experience and education to offer sound instruction, and whose sense of responsibility to their Alma Mater will not permit them to hold any but the highest educational ideals and standards. We are informed that President Eliot, of Harvard, while recently visiting the school, expressed himself amazed at the scope, thoroughness and standard of its papers, and another evidence of the great advance in the standard of this instruction is the fact that Columbia University and the United States government in the Army Post Schools use the school's instruction papers as textbooks.

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